DESCRIPTION AND ANALYSIS OF

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COMPUTER SYSTEMS AND SERVICES GROUP

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Last Updated: 08/11/87

GROUP: COMPUTER SYSTEMS & SERVICES (Thomas C. Roberts, Exec. VP)

PRINCIPAL DIVISIONS:

- Computer Systems (Gil Williams, Vice President)
- ETA Systems Inc. (Lloyd M. Thorndyke, President)
- Engineering Services (W. Fitzgerald, President)
- Professional Services (Gary Guardia, VP)
- Europe (Thomas Miller, Vice President)
- Pan Am/Pacific (Emmanuel Otis, Sr Vice President)

BUSINESS:

"T" is a leading supplier of computer systems and services to the scientific and engineering marketplace worldwide.

COMPUTER SYSTEMS AND SERVICES:

Revenue for the Computer Systems and Services Group totalled nearly $1.3 billion in 1986. It includes six business units.

The group's Computer Systems business unit designs, manufacturers and markets "T"'s CYBER line of high-performance computers, proprietary operating systems, information management and development tools, and integrated applications. These products are sold primarily to customers who require scientific and engineering computing in markets such as electric utilities, computer-aided engineering, higher education, petroleum exploration, weather forecasting and the government. Through its Scientific Information Services organization, Computer Systems offers specialized application services to electric utilities and supercomputer services.

ETA Systems, Inc., a subsidiary of "T", was established in 1983 to design and manufacture the next generations of supercomputers. The ETA-10 supercomputer is designed to perform 10 billion calculations per second, using eight processors and 256 million words of common memory. As a result of its research and development activities, ETA also provides the Company with advanced technologies in computer-aided design, high-density circuitry and packagin techniques, which can be incorporated in a wide range of future "T" products.

Engineering Services supplies hardware maintenance services for "T"'s computer products and for other manufacturers' products - primarily DEC and IBM. It is one of the four largest providers of thirdy party computer maintenance.

Professional Services provides consulting support to the Company's computer businesses. Its capabilities include software installation and maintenance, systems integration, systems analysis and customer application development. Professional Services also provides human resources consulting and services.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

The Europe and Pan Am-Pacific business units sell and support "T" products and services in 47 countries.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: Computer Systems

BUSINESS:

Computer Systems designs, manufacturers and markets mainframe computer systems, primarily the CYBER line, aimed at scientific and engineering applications within selected markets. It also markets ETA's supercomputers.

Systems are sold through a direct sales force of approximately 100 operating through sales offices throughout the U.S., and through sales activities outside the U.S. primarily in Europe. Significant sales are also made in the Pan Am-Pacific area: notable success recently has been in Taiwan.

"T"'s installed base, at the end of 1986, was approximately 1740 systems, (740 large systems and 1000 medium-sized systems) worldwide. Of these, 780 were current line products and 960 obsolete systems including the 3X00, 6X00 and 7X00 series, CYBER 7X/17X series and a variety of others (e.g., OMEGA, G-20, 31/3150, etc.), Exhibit 1.

Large scale (>$750K processor) systems installed in the U.S. are nearly twice as many as the international base, while in medium scale systems there are slightly more installed internationally. In terms of installed value, the international share is higher than the unit share due to the higher prices practiced internationally. Exhibit 2 and 3.

In the U.S., the base is 9% leased, 17% rented (generally under an extended agreement) and the remainder purchase outright. By industry sector, the breakdown is 30% Education, 25% Government, 16% Discrete Manufacturing, 10% Business/Services, 8% Utilities/Transportation and the remainder in Other.

Shipments of computer systems in 1986 were approximately 290, of which 91 were large (54 U.S.) and 199 medium scale (68 U.S.), (see Exhibit 4, 5, and 6.) The higher volume in overseas sales of medium-scale systems was due to the normal "delay" in adoption of new series internationally as well as the higher success in penetrating new accounts overseas at the lower end. The 990 model is selling well in the U.S. and abroad.

One of "T"'s major customers is the Chrysler Corporation which has over 30 CYBER systems installed.

"T" has industry/applications specialization in:

- In the Petroleum industry, "T" computer systems are used in connection with oil exploration. A significant share of worldwide seismic analysis is being processed on its systems. However, the recent decline in world oil prices has caused oil companies to substantially reduce budgets for exploration and capital equipment which has caused the Company to experience significantly reduced demand in its petroleum-related business.

- In the domestic electric utilities industry, it is the leading vendor of computer systems for managing electrical power generation and transmission among utilities providing over 200 megawatts of power. The Energy Management System (EMS) unit is part of Computer Systems and sells turnkey systems based on the CYBER 180 computers to electric utilities. Applications provided address utility needs from the time energy is generated to its delivery to the consumer. SCADA mapping and maintenance support are included.

  About 1/3 of energy production in the U.S. is now under management of "T" systems. Recent contracts have been obtained in California and Florida.

EMS has 27 contracts at an average of about $9 million. These are usually three year contracts for turnkey systems. EMS contributes about $65 million of standard CYBER sales per year. The remainder of the revenues come from software and service.

- In the weather forecasting market, "T" is a major supplier of computer systems for numerical weather prediction, particularly supercomputers used for weather forecasting.

- "T" also actively markets its computers to universities. At present, many large universities in the U.S. utilize computer systems for some of their scientific and engineering applications and for use by students and faculty in development educational software.

- "T" sells general-purpose computer systems to the federal government, primarily the Department of Defense and the National Aeronautics and Space Administration

(NASA).

- The Company also provides its standard CYBER 180 series computers to manufacturing customers. A portion of these systems are supplied in conjunction with specially designed computer-aided design and computer-aided engineering (CAD/CAE) application software. This software integrates, through a common data base, various functions such as product design, analysis, drafting and configurations that address mechanical engineering design. Competition is intense in this market.

BACKGROUND:

"T" was founded in 1957 by a group from Sperry Rand who had made important innovations in the technology for high speed scientific and engineering computing (characterized as floating point arithmetic). Within 7 years of its formation Seymour Cray, one of the founders, had built a computer capable of 1 million instructions/second (MIPS), the "T" 6600 which was achieved at the same time as a spectacular failure by IBM to achieve comparable performance. Within a further 5 years, he gave "T" the first computer capable of 10 MIPS, the "T" 7600. The performance of these systems gave "T" preeminence in large scale scientific computing, a field from which IBM progressively withdrew in order to focus on the emerging requirements for data base, transaction processing systems.

"T" was a focussed and respected company, dedicated to and able to communicate with the scientific and engineering community. They captured many of the world's most prestigious scientific and engineering computing centers from IBM and Univac; the "T" 6600 became a product line that was selected by smaller scientific centers, and evolved during the 1970's and 1980's into the CYBER 100, 170, and 180 series. The "T" 7600 became the basis of the top end of "T"'s CYBER product lines, represented today by the CYBER 950 and 995 multiprocessor.

"T" then broadened its business beyond the scientific market. IBM had reacted aggressively to "T"'s success in the scientific market and a legal suit against IBM in 1968 resulted in "T" acquiring IBM's Service Bureau Corporation. Along with other factors, including lease financing requirements, concern over its growth potential in the scientific and engineering market, and the desire to control peripherals on its own ystems led "T" to acquire Commercial Credit Corporation and begin to spread its operations towards other goals than the development of high-speed, floating point computers.Some of these, for example today's Computer Integrated Manufacturing Group, were the outgrowth of pioneering work in "T"'s customers in the 1960's to use scientific computers for engineering design.

During the 1970's "T"'s management also began an internal competitor to the development team led by Seymour Cray, the Star 100, which was based on a new architectural concept, vector processing, incompatible with the "T" 6600 and 7600 systems. In 1972 Seymour left to start Cray Research, and went on to develop the first computers to exceed the equivalent of 100 MIPS and 1000 MIPS. Cray Research now has over 100 customers and built its business by providing the high performance solution for many of the same customers who had bought from "T" in the 1960's and

1970's.

The Star 100 project was installed by only one customer, but it evolved into the CYBER 203, the CYBER 205, and the ETA 10. There are 35 CYBER 205 systems installed today and ETA is close to shipping its first operating system.

MARKET:

"T"'s Computer Systems Division operates in several markets. They are:

- Scientific, characterized traditionally by fast FORTRAN computing.
- Engineering - specifically CAD/CAE, an evolution from pioneering FORTRAN applications in engineering which have led to standardized codes, supporting design calculations, data bases, and custom workstations.
- Utilities - involving custom applications and process computers.
- Commercial data processing.

All of these markets present different requirements in terms of processors, systems software, applications software, storage, networking, and user device integration. Even in the high end of the scientific market, it is no longer possible to market a fast computer with only a FORTRAN compiler unless it offers a speed advantage over its competitors by a factor of 2-4; users now require integration with UNIX workstations, networking, interactivity, integration with other systems (PC's and Macintosh's are a prerequisite), and applications. Productivity is key; disruption of the computing environment of users is unacceptable and users no longer have the systems resources to take on systems software development and support. Each of "T"'s markets is addressed by specialized competitors. IBM is attacking all of them, and DEC and Prime are attacking some, and the new class of mini-supercomputers from Alliant, Convex and SCS offer superior scientific performance at competitive prices to "T"'s mid-range.

Approximately 25% of IBM's base of intermediate and large systems use features to accelerate their system performance in floating point computing, indicating that the market that "T" once dominated remains a large opportunity today.

"T"'s PRODUCTS AND TECHNOLOGY:

"T"'s current product lines include:

- CYBER 180 line of processors.

- ETA product line (developed by ETA but to be sold and supported by "T" - to be covered in a separate section).
- Several operating systems.
- Application software.
- I/O products.

CYBER 180:

The CYBER 180 series was first shipped in 1984, with subsequent enhancement to the 180A series announced in 1986. The series is built around three basic processors which are all field upgradable, the 810A, 840A and 90E. Each offers field upgradability to meet the growth needs ofusers, an important feature which increases the attractieness of outright purchase.

"T" has implemented even its smallest 8XX processors in ECL, a high speed technology; this gives high speed at the expense of product cost. A new product, the Model 930 has recently been announced. It is an entry system that provides much better price performance than the earlier models.

This unit, the size of an office copier and built for the office environment can act as a workstation, a file server or as a small processor.

The 930 is manufactured and marketed by "T" under license from a limited partnership of which a subsidiary of "T" is a general partner. "T" was the development contractor for the limited partnership.

"T" has recently announced a Model 910 workstation designed by Silicon Graphics. this is a full-feature system competing with Sun Microsystems, Mentor Graphics and other companies. They feel that the market opportunity still exists for them as there will be a rapid expansion in demand at two levels, the $5K - $10K microcomputer and the $50K - $100K full feature system. Price-performance will advance faster than in the commercial environment resulting in a "CRAY on a desk within 5 years" - notably this comment was made by a "T" employee!

Major features of the processors are as follows:

Processor	Price ($K) Basic CPU	Speed MIPS	Memory Max MB	Upgradeable To
930-11	60	1.8	64	Possibly to -31
930-31	126	3.0	64	
810A	121	0.8	64	830A
830A	175	1.2	64	830A dual CPU
840A	580	3.7	128	850A
850A	830	5.6	128	860A
860A	1240	8.5	128	870A-860A dual
950E	2350	42+	128	995E
995E	3810	63+	128	

+ Indicates that these processors also have vector capability.

Although the 930 is a new system, and provides better price/performance than the 810A, 830A or 840A systems, it does not yet replace them, for historical reasons.

During the 1960's, systems architects adopted different solutions to represent the numeric range of calculation. Word lengths of 32, 36, 48, 60 and 64 bits were used on different systems; IBM chose 32/64 for their general purpose systems; IBM chose 32/64 to enable their systems to be used for both character handling commercial applicatins and word oriented scientific systems. Seymour Cray chose 60 bit words for his scientific systems, which "T" has been using in its attempts to penetrate character oriented commercial data processing. The computer industry has slowly standardized on 32/64 and "T", introduced the CYBER 180 series with the ability to run in 60 bit mode with its older systems to provide compatibility for its existing customers, or in 64/32 bit mode with a new operating system. The new 64 bit mode also enables CYBER 180 users to utilize the larger memory available on their systems.

This radical change to "T"'s product line was coincident with a second, the rationalization of the two operating systems in use among "T"'s users (NOS and NOS/BE). This problem is also common to IBM and DEC, and evolved, in T"'s case, from the competition in the 1960's between fast batch processing systems that optimized the speed of the hardware and timesharing systems that set out to optimize the productivity of the end user. "T"'s new operating system (NOS/VE) is a completely new design that has its roots in the highly secure MULTICS system, and adds significant new functions including UNIX. NOS/VE is different from either of "T"'s current operating systems, not only in implementation, but in user interfaces and for systems operation. Implementation is seen by some users as a migration equivalent to installing another vendor's equipment. This appears to have led some customers to review the position of "T" in their future computing strategy.

The 930 is the first product from "T" that only offers these new features; a 64 bit word with character processing and the NOS/VE operating system. As few users of "T"'s earlier systems have migrated to NOS/VE, their ability to use the 930 is very limited, hence its thrust as a system for new markets. Because the 930 offers better price performance than the 810A, 830A and 840A, this forces "T"'s upgrading customers to pay a premium and is unlikely to last long. It therefore seems likely that the 930 may herald the replacement of the small and intermediate CYBER 800 models.

The design of "T"'s operating software provides a full range of services, with a wide range of industry standard application programs. Like other systems manufacturers, however, "T"'s systems have been relatively "closed", making it easier for users to integrate "T"'s devices than those of its competitors. This strategy is increasingly unpopular with users who want to integrate UNIX and other minicomputers and workstations, especially PCs. In addition to its own networking scheme, "T" is also supporting the widely used networking standard Ethernet, which provides a basis for connecting workstations, PCs and Macintoshes.

The range of engineering and scientific applications software is focussed on the industry sectors in which "T" has achieved success. Users criticize the range of applications, and the functionality and lack of support for he older operating systems.

"T" has a new relational DBMS developed by Batelle which is purportedly very good.

There is a major communication software gap addressing the very high bandwidth needed for workstation/mainframe communications in scientific/engineering environments.

"T" also has two other procucts that offer high computing speed for specialized markets. These are the MAP V array processor, and the CYBERPLUS loosely coupled arithmetic processor. Array processors are used for signal processing, e.g., in seismic analysis; we have been unable to locate any installations of CYBERPLUS.

COMPETITION:

"T" sales organization has a history of being an effective and aggressive competitor.

The processor technology of the CYBER 180 series appears to be comparable to that of its major competitors. At the top end, the 990E is comparable to the processor speed of IBM's top and 3090 with similar vector processing features for floating point users, and with exceptional channel speeds. The 990E is, however, limited to a multiprocessing configuration of two CPU's, and that only when the user has converted to the new operating system NOS/VE, while the 3090 can include a complex of six CPU's. At the lower end of the range, the 810A through the 870A appear comparable to IBM and DEC small and intermediate systems, without offering the high speed capability for floating point users that is now being offered by the $500K vector and multiprocessing mini-supercomputers from Alliant, Convex and SCS.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: Computer Services (continued)

The following table shows a comparison between the CYBER product line and some of its major competitors:

Processor	Price ($K) Basic CPU	Speed MIPS	Memory Max MB	Upgradeable To
SMALL				
"T" 930-11	60	1.8	64	Possibly to -31
930-31	126	3.0	64	
IBM 810A	121	0.8	64	830A
830A	175	1.2	64	830A dual CPU
9370-20	44		16	
9370-40	71		16	
9370-60	119		16	
9370-90	222		16	
DEC				
INTERMEDIATE				
"T" 840A	580	3.7	128	850A
850A	830	5.6	128	860A
IBM				
DEC				
SCS 40	595	17+	128	
LARGE				
"T" 860A	1240	8.5	128	870A-860A dual
950E	2350	42+	128	995E
995E	3810	63+	128	
IBM				
CRAY XMP1				

+ Indicates that these processors also have vector capability.

Competition to "T"'s products will also come from the workstation vendors, Sun and Apollo, both of whom are now supplying systems with 10 MIPS performance in a price range below $100K.

It is hard to differentiate "T"'s products from their competitors in terms of performabce, price/performance or functionality, and their limited presence in many markets inhibits their growth rate in applications.

In 1986 "T" took price cuts of 26-37% across the CYBER 180 line.

The fast and accelerating pace of technology introduction from companies with no history like Sun and Convex makes it hard for traditional vendors to maintain their competitive position over the broad range of products that they have introduced in the past, and whose users expect to see improved.

BUSINESS EVALUATION AND FORECAST:

At the end of 1986, "T" had 1735 systems installed, 53% of which are in the U.S. Of these, 681 were CYBER 180 and the other 61% were older systems. We estimate that they have an average of about 1.5 systems per customer site, which is probably nearer to 2 in the large systems sites.

The normal migration into the vendor's latest product line is in progress; it has already peaked in the U.S. but not internationally.

The success of "T"'s future in computer systems will be determined by:

- Their ability to win new accounts from competition in each sector in which they compete.
- Their ability to increase the value of their installed customers, upgrading rental users and winning the replacement business from purchased sites.
- Their ability to not lose their current lease customers.

NEW ACCOUNTS:

"T"'s large CYBER mainframes appear to offer competitive price performance for scientific applications, without an edge that would enable them to overcome the greater range of system options that IBM offers. In the commercial marekt it is hard to see them being successful against either IBM or Cray in accounts in the

990 class.

There is a greater possibility that they could succeed in University or Government accounts, where they have traditionally shown flexibility and aggression. We think it unlikely that they could win more than five new customers/year in a two year window.

In intermediate scientific/engineering account, "T"'s systems meet competition from IBM, DEC, and the mini supercomputers, and their advantages are difficult to identify. The heavy price cuts of 1986 suggest that their products lack sufficient advantages. Although the intermediate systems market is larger, we believe that it is harder for them to win new accounts, and have assumed five new accounts/year in the U.S., with a further five in International, where their success seems to be higher. We do not believe they will win new accounts in commercial customers.

In small systems, they appear to have had more success, especially in International. The new 930 is a much more competitive system, and has software that enables it to be sold for office applications. "T" has sold around 165 CYBER 810 class systems, and we believe that they may be able to close as many as 50 new accounts in each of the next two years.

ACCOUNT GROWTH:

The pattern of upgrades from survey data and customer interviews shows the following:

Approximately 25% of "T"'s lease or rental customers have taken a long term option of two to four years. In order to generate cash it is tempting to accelerate the purchase of the lease base, and "T" has been doing this for at least the last three years. There is a greater propensity to lease at the low end of the systems scale, and as this is expected to be the most successful sector of "T"'s business, should add to their lease inventory; we have assumed that 50% of the new 930 systems are leased. The dollar value will, however, be small because of the lower leverage of small systems, and we see the lease stream continuing to reduce.

A component of the lease base is the use of leased I/O on purchased systems, and this is likely to continue.

Customer interviews show that a high percentage do not expect to stay with "T". We expect to see this take the form of purchase customers who will add other vendors equipment to their "T" installation, and the non-extension of leases. We have used an assumption that 20% of their base will take this option, so that

DIVISION: Computer Services

20% of lease customers do not renew an average five year lease option per year, a loss of 4%/year.

In addition, the maintenance of the revenue stream relies on purchase customers renewing their systems. This can take the form of a modest increase in budget for a substantial increase in performance, or the addition of a smaller system, indicating that the real computing has migrated to another vendor, and a small "T" system is being added to retain some compatibility. With a 20% attrition in this buying cycle, this would lead to replacement at around 30% of the price of the replaced system, a 14% drop in annual purchase revenue from upgrades.

The markets targetd by CS are worth approximately $5 billion per year according to the unit's Vice President and were until recently centralized processor markets; now the trend is towards decentralized, value-added markets with a need for departmental processors tied together by a network. However, "T" has fallen behind IBM and DEC in this area and does not offer good connectivity with other vendors' PCs and minicomputers.

A July, 1987 survey revealed that, while end-users were very happy with the hardware and system software performance of "T" products and were complimentary on their reliability, they felt that NOS was outdated and NOS/VE unproven. The upgrade is seen as a major conversion and is prompting users to evaluate other vendors as alternatives. Other reasons cited include:

- For commercial installations: the availability of more commercial software on competitive systems (IBM in particular), the desire for IBM shops to become all IBM and the difficulty of justifying "T" in the face of rapid technological change.

- For scientific/engineering users: the fact that most engineers coming into the workplace are already familiar with DEC VAX is a strong incentive to have DEC systems since it is not possible nor desirable to continuously spend money training them on "T" systems (this applies particularly to users that have a large influx/outflow of engineers on a project basis).

Analysis fo "T" sites shows that their systems are, in many cases, being augmented by other vendors' systems, primarily IBM and DEC.

Application conversion to a competitor product is not seen as a major problem because most CYBER sites use FORTRAN and third party applications that run on competitive products anyway. "T" has been late releasing software as per their own schedule and compared to the competition.

The user group is very loyal and believes that "T" has become more responsive, but the questin is "can they move fast enough to catch up"? the greatest danger is where commercial applicatins and/or departmental systems are important. There is less danger where raw number-crunching (numerically intensive computing) and/or accuracy and/or reliability are required.

Computer Systems is facing declining sales and installed base and an eroding market share in the U.S.; in Europe sales continue to grow but without gaining market share. "T" has also faced decreasing margins recently due to competitive pressure on prices. CS has not been able to keep pace with manufacturing productivity improvements to slow the margin erosion and is behind in systems software and (particularly) applications software sufficient to support more than niche participation in either the commercial or the scientific and engineering market. As a result, "T" is steadily losing ground in all of its CS markets primarily to IBM and DEC.

The recent announcement of a joint venture by CRAY and DEC to close the gap between their systems puts further pressure on "T" by attacking its primary market.

The lack of expansion of U.S. systems sales and of the installed base is expected to continue in the forseeable future and represents the biggest problem facing "T". In the short-term, this lack of U.S. performance will be partially off-set by sales growth in International marekts but the root cause - lack of competitiveness and differentiation - will continue. In fact, some of the same measures being undertaken by "T" to improve the profitability of this unit (consolidation of marketing and sales) will accelerate the sales downturn in the US.

The unit is in the process of consolidating management, sales and marketing operations, as well as employee levels and inventory levels. These are all short-term solutions to a fundamentally long-term problem: continued competitiveness in a technology- and applications-driven market that requires constant infusions of R&D capital.

The U.S. and International sales and support operations are separable and have value both for their customer base and for their sales and support organizations.

The following factors enhance the value of this segment:

- CS has a full, compatible range of computers from the minicomputers to the top of mainframes.
- CS has a large base of quality accounts in the technical market (which is growing faster than the commercial segment and which requires less support than that segment).
- CS products benefit from good reliability, loyal customers and operations have produced a profit in the last two quarters.

The following factors reduce the value of this segment:

- The product line is being gradually squeezed between increasingly powerful DEC systems eating away at the bottom of the Cyber line and down-sized versions of CRAY supercomputers competitive with the upper end of the line, both of which target the same markets as the Cyber products on a broader scale and with more software.

- There is a lack of focus on necessary system and applications software.
- The push to upgrade users to the new NOS/VE operating system is opening the door to competitive replacement of the installed base.

GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: CIM (Computer Integrated Manufacturing)

MARKET:

This unit is now integrated into Computer Systems and the sales forces combined. This unit is mislabelled in that it does not address the total CIM market but only the CAD/CAE/CAM market. It primarily sells and supports CYBER-based CAD/CAE/CAM workstations and software for electronics and mechanical engineering applications (with ICEM) and to the automotive industry (with MCAD). Some integration work is done on a fixed-price/fixed schedule basis. Systems are sold on a turnkey basis. "T" concentrates on automation integration and control for large manufacturing systems. This is different from the more typical workstation/mini computer-based CAD/CAM companies.

The unit started in 1983 and has grown to over $100 million in revenues. "T", however, has made substantial investments in software and the unit has not been profitable.

One of the major clients is Northrup Electronics Division which has spent $20 million with "T" in the last three years on MCAD and ECAD integration. There is probably another $20 million to go with this client.

The market for true CIM is systems integration in the Process and Discrete Manufacturing sectors. The integration thrust is an attempt by users to make better use of the systems already installed (via interconnection, networking, etc.), to delegate the purchasing power and authority to the operational units (departmental processing) rather than adding to the central facility and to link the centers of management, planning and design with the shop floor. This thrust began three years ago in the US and has started in international markets.

"T"'s CIM unit is narrowly focussed, which is a plus in terms of the development of dedicated, specialist skills software and market position.

"T"'s ICEM (Integrated Computer-aided Engineering and Manufacturing) solution provides software products and services that are used worldwide to improve design, engineering and manufacturing productivity and costs. They involve a variety of materials, including plastics.

Four major areas of manufacturing served by ICEM products include: information management, complex geometry creation, engineering analysis and systems integration.

INFORMATION MANAGEMENT

ICEM Engineering Data Library (EDL). ICEM EDL integrates all CAD/CAM applications under a single computerized design management and control system.

Information Management/Data Management (IM/DM). This ICEM information product enables non-technical users to enter, format and retrieve information, manipulate multiple data bases, produce complex relations and reports and devise queries and commands. ICEM EDL is built on this advanced, fourth-generation relational data base manager.

ICEM Configuration Manager (CM). A companion product to ICEM EDL, ICEM CM provides total product control throughout the life cycle of a product or project.

COMPLEX GEOMETRY CREATION AND MACHINING

ICEM Solid Modeler. Enables engineers to create solid models by combining primitives such as spheres, cones and toroids to create any three-dimensional object.

ICEM Design/Drafting/Numerical Control (DDN). Using data from the ICEM Solid Modeler, this program supports construction of two- and three-dimensional geometries.

The ICEM Numerical Control module allows generation of cutter location files directly from design geometry, thus bridging the gap between design and manufacturing.

ENGINEERING ANALYSIS

ABAQUS (by Hibbitt, Karlsson and Sorensen, Inc.)--A leading analysis software that solves advanced structural and heat transfer problems.

ANSYS (by Swanson Analysis Systems, Inc.)--A leading general-purpose finite element analysis program used to solve complex problems in the design and analysis of products and structures.

MSC/NASTRAN (by MacNeal-Schwendler Corporation)--A finite element analysis program that determines how a specific structure made of a given material reacts to various environmental changes.

PATRAN II--This is a suite of interactive graphics programs which generate finite element models for structural analysis.

SPECIAL APPLICATION SOFTWARE--In addition to these design, analysis, machining and information management capabilities, ICEM includes special software modules for electronic circuit design, hydraulics, kinematics, flat pattern layout, nesting, and facilities design.

SYSTEMS INTEGRATION

"T" ICEM provides all the elements for an integrated CAD/CAM system. It can integrate existing automated systems and unlike components into a homogeneous system.

Personal computers and stand-alone and networked workstations and machining devices from various vendors can be made communication compatible. Process planning and information management systems can be added.

"T" ICEM includes a broad range of delivery vehicles that range from standalone and networked terminals and workstations to "T" CYBER 180 Series 800 computer systems.

ICEM PLASTICS

The newest addition to "T"'s ICEM solution is a fully integrated approach to including 21 applications for the plastics industry.

"T" has one of the computer industry's broadest range of compatible delivery systems for automating manufacturing operations from design concept to finished product.

ICEM delivery systems enable users to begin running ICEM applications from a single terminal linked to an ICEM system and increase their capabilities to standalone workstations and networked units supported by an on-site "T" CYBER 180 Series 800 system.

1. The CYBER 910-300. The first model in a family of large-memory, UNIX-based, integrated graphics workstations featuring high-speed and real-time 3D graphics. Prices start at $40K.
2. The ICEM 793 Intelligent Workstation. Includes high-level ergonomic features and distributed processing capabilities. The ICEM 793 operates in a standalone mode, or it can be networked with other "T" computers for data base management and engineering analysis.
3. ICEM 794 Workstation Cluster. Accommodates two graphics stations that can be networked to a Control Data host computer. It can also support printers and plotters.
4. ICEM PC 4107 Emulator. Converts the IBM PC/XT, PC/AT and other personal computers into terminals capable of accessing a

wide range of ICEM solution software.

5. ICEM/120. A super miniprocessor that supports up to 6 workstations and offers low-cost entry to ICEM applications with extensive on-site design/drafting, office automation, local timesharing and batch processing.

6. ICEM 800 System. Drawn from "T"'s CYBER 180 Series 800 computers the ICEM 800 system provides on-site the resources required to perform complex CAD/CAM functions in design/drafting, analysis, numerical control and data base management. It can support from 4 to over 40 workstations with interactive and simultaneous processing capabilities.

"T" recently announced the ICEM™ Electronics CAD Suite that now shares a common user data base with other ICEM applications. The integrated system runs on the CYBER 910-300 workstations.

The high performance CYBER 910-300 introduced in late 1986 features transformations per second (TPS) ratings more than twice those of mid-range 32-bit workstations, and MIPS (megainstructions per second) ratings are typically 50% faster. Compared with personal computers, high performance workstations compare even more favorably. The 910-300 has 3D real-time graphics, UNIX operating system and industry standard

(OSI/Ethernet) netowrking capabilities. Prices start at approximately $40K.

ELECTRONICS SUITE

The suite of products "T" offers for electronics design and engienering applications is made up of many pieces from three functional areas: computer-aided engineering, which includes engineering, analysis and other tools; computer-aided design, which handles printed circuit board layouts and circuit routing; and computer-aided manufacturing, which links CAE/CAD with numerically controlled manufacturing tools such as photoplot drivers and automated drilling equipment.

ICEM Electronics software will be available after September 1, 1987. Pricing for the three major products -- ED-SCHEMATICS™, ED-LAYOUT™, and ED-ROUTER™ -- will be $10,000 each.

MECHANICAL CAD SUITE

The new integrated ICEM system offers packages that allow steps done typically by a mechanical engineer to be carried out sharing the data base that the electronics engineer uses. ICEM DDN™, for example, is the premiere 3-D design and drafting package from "T", and it already runs on the CYBER 910-300 workstation.

Because of this integration, "T"'s ICEM can reduce engineering time, simplify design work, cut product development cycles and trim costs. Compared with systems where information is passed on paper between the mechanical and electronic engineering functions, such a comprehensive information management system will help make the electronics manufacturing industry more competitive.

The growth of sales of this unit has been satisfactory but not as strong as "T"'s competitors who, for the most part, address a wider spectrum of user needs within the CIM market. The sales of this unit are 30% software and services, and 70% hardware (50% "T" products and 20% special purpose). About 80% of revenues are from mechanical CAD and most of the remainder for electronic CAD.

The following factors enhance the value of this unit:

- There is a market for CYBER-based CAE products.
- Some specific sector needs have been addressed (electronic and mechanical engineering, automotive engineering, plastics etc.).
- The CYBER base is still strong in the manufacturing industry, offering opportunity for current and expanded

product offerings.

This is a typical marketing effort by "T": fragmented, incomplete and, until recently, organizationally separate from internal groups most capable of addressing the central customer need.

This business has potential for dramatic growth; competition such as Mentor Graphics have grown to be substantial ($100 million plus) companies very rapidly. The market is forecast to grow at 40% per year.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: SIS (Scientific Information Systems)

The Scientific Information Systems division was formed in late 1985 with the merging of "T"'s UIS Company and CYBERNET Services (U.S.) operations.

UIS Company (formerly United Information Services) was acquired from United Telecommunications, Inc. by "T" in January 1984. Headquartered in Overland Park (KS), the former UIS unit provides remote computing services throughout the U.S.

Four separate processing services are offered. A sampling of available applications is shown in Exhibit 1.

- The APEX Service provides interactive and remote batch processing. The applications program library contains more than 300 programs addressing the needs of the energy, telephone, and manufacturing industries, and engineering, financial, commercial, and graphics applications.
- SUPRA is a CRAY-based remote batch processing service with interactive utility management and manipulation capabilities. SUPRA's applications are targeted to the scientific and engineering fields, including programs in civil and structural analysis, nuclear engineering, and large-scale integration design.

- The DEC-10 Service provides general-purpose remote computing with emphasis in the business/commercial areas. It accommodates both interactive and batch environments.
- The CENTRA Service is designed to provide access to IBM hardware, software, and networking capabilities. Users can access CENTRA to try new IBM releases, test new products, or add to in-house IBM processing capabilities.

The part of SIS that was formerly CYBERNET Services provides computing power by using a variety of hardware sizes, ranging from desktop workstations to large mainframes and supercomputers. The Rockville (MD) Supercenter, the largest commercially available remote computing service, contains a CYBER 205 Supercomputer with memory capabilities representing 64 million bytes of main memory, and seven of "T"'s largest mainframes, including 800 Series equipment. Applications are targeted to the electrical utility, electrical/electronic engineering, mechanical engineering, and government markets. A profile of the major applications offered is presented in Exhibit 2.

The CYBERNET*EXPRESS Engineering Application Systems, introduced in March 1985, are turnkey products based on IBM PC or compatible microcomputers.

Application software available for CYBERNET*EXPRESS include: Electronics Designer, for schematic design and analysis; Structures, for finite element structural design and analysis; Piping, for analysis and design of piping systems and support; Power Systems, for design and analysis of commercial and industrial electrical distribution systems including analysis of power protection; and Project Manager, for management of technical projects. CYBERNET*EXPRESS software pricing ranges from $3,500 to $8,550.

Professional services provided by SIS include application analysis and design, custom contract programming, and system maintenance.

SIS operates two data centers that had been part of UIS:

- Kansas City.
  - 1 CYBER 175/130.
  - 1 CYBER 175/174.
  - 1 CRAY-1 Model S/2000.
  - 2 IBM 3083s.

- Pittsburgh.
  - 16 DEC 10s.

SIS also operates a Supercenter in Rockville (MD). The Supercenter currently has a CYBER 205 supercomputer and seven 800 series CYBER mainframes, using NOS (Network Operating System) and NOS/VE (Virtual Environment). International access is also available. A dedicated CYBER 800 in Rockville is used for ICEM applications.

Of their $100 million 1986 revenues, $57 million were from U.S. federal government and approximately $15 million from electric utilities.

The unit is currently operating profitably and is growing.

One area of emphasis is supercomputer services offered on CRAY and CYBER 205 computers. Competition in supercomputer services comes not only from companies such as BCS, but also from government and NSF funded centers at universities. NSF-funded the establishment of these centers but has not followed through to support their operation, so the centers are looking to other sources for revenues.

There is a potential market in running supercomputer centers. General Atomic is doing this very successfully at UCSD.

Market segments for supercomputer services include:

- Telephone rate modelling/analysis: this is 40% of "T"'s non-government, non-electric utility, business and growing.
- Structural analysis - will gravitate to in-house mini-supercomputers.
- Fluid dynamics (air, water).
- Petroleum reservoir modelling, which may resume growth.
- Biotechnology, an emerging market, particularly with pharmaceutical companies.

With the exception of the federal government and the supercomputer services segments, the plain remote computing services market continues to erode, attacked by minicomputers, workstations and other in-house alternatives. This erosion, however, is now slower: there will always be a base of business for overflow processing, "crash" project work, and services for companies that choose not to have their own systems for reasons of cost, growth rate, personal preference, etc.

The federal government market will grow slowly and will become even more price competitive. However, it is largely separable and could have a dedicated center, the Rockville Center.

Other SIS businesses which are related to specific industry/ application areas should be transferred to the appropriate "T" units. They can be used to support the sales effort for systems, as back-up to in-house systems, as overflow vehicles and for special applications.

"T"'s experience in supercomputer services dates to 1978 when it became the first commercial supercomputing service supplier, offering access to a STAR 100. That technology was subsequently upgraded to the CYBER 203 and then to today's CYBER 205 service.

Concurrently, UIS was adding a CRAY supercomputer to their CYBER and IBM-based offering to become the first commercial CRAY service provider. Access to a new CRAY X-MP/24, called the SUPRA Service, became available in February, 1987. An ETA 10 System is now in the planning stages for a 1988 service introduction.

While the growth of micro, mini and super minicomputers has significantly eroded the traditional remote data processing market, the demand for high-end computing services remains strong. Industry revenues for commercial supercomputer processing services (CYBER 205 and CRAY) increased to an estimated $90 million in 1986, up 40% from 1985 levels. By 1991, the market will be between $150 million and $200 million per year.

A new service, introduced in May 1987, Equivalent System Processing (ESP), enables customers to purchase a block of supercomputer processing each month. That block consists of processing hours equivalent to a fraction of a CYBER 205 or CRAY X-MP/24 Supercomputer or equivalent to the monthly capacity of any popular minicomputer, mini supercomputer or mainframe system. For example, the monthly processing power of a VAX 8200 may be achieved using either a CRAY X-MP or a CYBER 205 supercomputer for less than seven system hours.

"T" is still rationalizing its services and has sought to sell its DEC-10 service area in Pittsburgh. That unit has approximately $7 million in revenues, is profitable and has one major government contract.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: SIS (Scientific Information Services) (continued)

There has been a steady erosion in revenues and profits in past years recently accelerated by the drive to cut costs by closing centers. It is difficult to recommend growth strategies for a services group composed of so many different hardware/operating system environments:

- APEX	Cyber 174/5 and Cyber 730
- SUPRA	CRAY I
- CENTRA	IBM 3083
- "DEC-10"	DEC-10
- SUPERCENTERS	Cyber 800 series, Cyber 205

The overlap in applications is enormous, particularly in Manufacturing, Construction/Design, Graphics and Petroleum processing.

This unit can be rationalized and is separable into the individual system and market services offered. Parts are readily saleable, e.g., the DEC-10 services to ADP, the CENTRA service to Boeing Computer Services both of whom are active in the kinds of business that these SIS units handle. The SUPRA CRAY-based service offers a window on supercomputer users that can be either targeted by an ETA 10 or supported by a service based on that computer. The unit is scheduled to break even this year.

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The market for many of the services offered is dying, eaten by minicomputers and other in-house alternatives. Also it may prove unwieldly and expensive to achieve the rationalization that is so desirable.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: ETA Systems, Lloyd M. Thorndyke, President

BUSINESS:

ETA Systems, a subsidiary of "T", designs and manufacturers "the next generation of supercomputers" (currently the ETA-10) and supports the CYBER 205 supercomputer (as of 01/01/87). The sub also provides "T" with CAD technology, high density circuits and packaging to be incorporated into "T"'s future products. The unit has 550 people and has partnership agreements with other high-tech companies such as Honeywell (main vendor for the advanced logic chips). The ETA-10 offers scalar and vector processing.

This is a "deep pockets" market, dominated by R&D investment in fast moving technology by a handful of Japanese and U.S. companies (with the Japanese emerging as leaders). IBM has also announced a new commitment to supercomputer development. Although the returns can be high, the commitment needs to be on-going, not one-shot.

Internal Factors: The first ETA (in single processor configuration) is in Beta test at the Florida State University. No Operating System is currently available. "T" needs to retain the CYBER 205 base which needs an upgrade path. Also, ETA is a visible commitment by "T" to continued R&D in the field of large systems with benefit at the marketing/company image levels. ETA also offers "T" CAD and VLSI technology which are mandatory for the core business.

There is a significant business for CYBER 205 and other top-end CYBER customer upgrades as well as a very strong demand for supercomputer power in the gigaflop range. ETAs can be delivered in configurations ranging from single to eight processors worth from $5.5 million to $22 million a system.

It is possible to view ETA in the same light as Bell Labs used to operate i.e., as a funded R&D unit that operates on a strict, contract-based plan, supported by industry, government and private development projects. Currently, "T" directs the development strategy in a much narrower focus than might be possible if the unit were separated. In addition, "T" cannot support the unit functioning at its maximum research growth capacity due to budget restrictions.

ETA would have value to companies looking to complement the top end of their systems lines with supercomputer technology that has reached the shipment stage. The prospective buyer would probably have to be a U.S. company due to the nature of the advanced technology.

There is a strong demand for this type of product (assuming it can be manufactured to "T" reliability standards) and a ready demand from the current "T" base. The product could compete with the Cray line. It has a beneficial "comfort" value for new and current CYBER customers who see trickle-down benefits from leading-edge technology developments.

The system is unproven in operating conditions and has no operating system (not due until 1988). In addition, when it arrives it will support NOS/VE which is good for the CYBER and not much else.

BACKGROUND:

ETA is in the late stages of developing a supercomputer, the ETA10, which is planned to achieve a speed of 10 million floating point operations per second (MFLOPS-see Appendix on Vector Processing). The ETA10 has its roots in the STring Array Processor (STAR), a scientific computer of innovative architecture developed during the late 1960's/early 1970's by Jim Thornton at "T" before he left to found Network Systems Corporation.

The STAR differed from other systems, including those of Seymour Cray, in that it was designed for vector processing. The early promise of STAR was not realized, and only a single system was installed, because users of the scalar "T" 7600 found that by restructuring their programs for the STAR, their performance on the 7600 improved, and exceeded that of the STAR.

The STAR development team added scalar capability to the design, and the CYBER 203 was announced in 1980, followed by the announcement of the CYBER 205 in 1982. The CYBER 205 had a claimed maximum speed of 800 MFLOPS, apparently surpassing the Cray 1, with a peak of 160 MFLOPS, and the new Cray XMP, with a maximum rated speed of 240 MFLOPS for each of its two processors.

Although peak speed alone would seem to indicate that the CYBER 205 is faster than low end Cray XMP systems being sold today, the system has not sold in double figures for several years. As with the STAR 100 it was found that the very high vector speed of the CYBER 205 was outweighed in practice by its poorer performance on scalar and short vector problems relative to its major competitor, the Cray 1/S and XMP systems (see Appendix on Supercomputer Performance). The CYBER 205 has, however, been more successful than its predecessors, particularly in meteorology, aerodynamics and the University markets. A total of 35 systems are now installed.

In 1984, "T" formed ETA around the CYBER 205 team with the hope of creating entrepreneurial drive and raising public capital to support the development of the ETA10. The design goal for the ETA team is to build a multiprocessing system with a peak performance of 10 MFLOPS, a goal identical to that stated for 1990 by the Japanese national supercomputer program.

"T" owns 88% of ETA today, with the remainder being owned by the employees.

THE SUPERCOMPUTER MARKET:

The traditional market for the leading edge scientific computers now referred to as "supercomputers" has been in U.S. and overseas Government laboratories, where the systems have been justified by security and weapon simulation applications since the test ban treaty.

The market has evolved slowly. The installed base of 10 MIPS "T" 7600 systems that were introduced in 1969 probably never exceeded 100 systems. At the end of 1980, after four years of shipments, Cray Research had only installed a total of 22 processors. In 1986 alone, however, Cray shipped 40 new systems with a total of 107 processors, each of which exceeded the performance of the 1980 model by 50%.

The following table shows annual installatinos by Cray, "T", and other vendors during the last five years. It should be noted that the figures show new systems only and that multiprocessors are counted as a single system.

	1982	1983	1984	1985	1986	TOTAL
CRAY	15	16	23	28	40	157
"T"	7	10	6	4	5	35
OTHER (Japanese)						62+

+ Only 7 of 62 systems are installed outside Japan.

Nine Cray and four "T" systems are internals. The Crays represent 60 sites in the U.S., and 51 overseas. The CYBER 205s represent 18 U.S. and 12 international sites.

By industry, worldwide sales are split as follows:

	CRAY	"T"	OTHER
Meteorology	5	6	2
Defense	19	0	0
Electronics	2	0	0
Research	20	5	11
Oil	20	3	3
Aero Eng.	15	3	1
Nuclear	2	2	2
Auto Eng.	7	1	1
Universities	15	11	13
Service	4	0	2
Other	1	0	1

It can be seen that Cray is very strong in defense, research, oil and engineering, with "T" relatiely strong in meteorology, and the universities.

These figures do not include IBM 3090 installations that are equipped with the 3090 Vector Feature. Many of these are capable of competing with Cray and ETA in those customer who are prepared to trade some edge in performance for ease of integration.

The supercomputer market has been forecast to grow to $1 billion/year by 1990 (Cray's revenues alone for 1986 were $458 million, boosted in the last three years by substantial customer upgrades to the $15 million XMP48).

The expansion of the market is being justified by increasing acceptance of numerical simulatin as a cost effective adjunct to experimentation (see Appendix on Numercial Simulation). In each new industry to adopt the technology, the pattern has been that a small initial group of users pioneers application development; this is followed by the development and acceptance of standard applications that make up the benefits of the technology available to a wider user group who could not support the initial research investment.

It is still true that high speed and FORTRAN are adequate to justify a new system to the pioneering groups who have the resources to accept limited support in order to achieve breakthroughs in application productivity. Even among these users, the pressure for user productivity makes it difficult to justify a system with limited support unless the speed advantage over its competitors exceeds a factor of 2-4. The expanded market is not accessible without adequate applications and stable system software because of user resource limitations.

Given the development of an adequate operating system and application support, Cray Research have demonstrated that multiprocessor systems priced at up to $20 million can be cost justified.

ETA PRODUCTS AND TECHNOLOGY:

The ETA10 is designed tooperate at a clock rat eof 7nS. It is unusual in that it is implemented in CMOS technology, in contrast to the higher speed ECL used in the systems of Cray, IBM, and all three Japanese companies. The clock rate of the processor is one of the most critical determinants of CPU performance (see Appendix on Clock Speed and Technology), and ETA expect to achieve 7nS by using cryogenic temperatures and exploiting the higher density of CMOS to compensate for its lower switching speed.

In conventional systems the clock speed can be established with certainty by using known components. When the components to be used are at the leading edge of semiconductor technology there can be substantial risk in the date at which adequate quantities will be available at the right level of performance for prototype completion, and later for production.

The ETA10 is currently running at a clock speed of 12.5nS, which compares to 20nS in the CYBER 205. It is predicted by ETA that the clock will be reduced to 10nS by the Fall of 1987, and to the design goal of 7nS at the end of the year. This will represent a speed improvement of 80% over the system that was shipped to Florida State in late 1986.

Without access to data on the technology we feel that theer are still significant risks that the design speed may not be achieved, that there may be delays in achieving it, and that the availability of production quantities of components will be delayed. Failure to achieve design speed could be drastic for the program. Delay will damage market penetration for the reasons addressed in the Business Forecast section below.

CMOS offers advantages in component cost. It is not clear whether these still translate into system cost advantages after including the cost of the packaging.

A major difference between the ETA10 and the 205 is the implementation of multiprocessing. Withup to 8 processors, each with multiple pipes to increase performance, a fully configured system is designed to be capable of executing 10,000 MFLOPS (10 GFLOPS) on 32 bit operands.

The ETA10 architecture is highly compatible with that of the 205, so that applications programs should be ported easily. The introduction of multiprocessing will, however, add a great deal to the complexity of the system software, and a phased implementation is likely. We estimate that the initial system will provide the ability to load and scheudle a single processor and limited I/O, with subsequent releases adding support for multiprocessing, and later adding scheduling, operating and diagnostic support. We would not expect the system to be capable of supporting full system benchmarking in a competitive environment before mid 1988. Prior to that time ETA is likely to concentrate on demonstrating performance to existing 205 users and on single jobs. The initial operating system to be available is likely to resemble that of the 205, with UNIX promised for later.

An efficient FORTRAN envrionment is key in this market, and with the announcement of FORTRAN 2 on the CYBER 950 series, it is to be expected that ETA will offer a FORTRAN for the ETA10 that vectorises automatically. The lack of this capability was a major disadvantage for the 205 in competing with Cray.

It has been suggested that additional versions of the ETA10 may be produced. These re described as PIPER, a single processor version of the ETA10 running at full speed, and a less expensive system that would not be refrigerated, and would run at lower speed. ETA claims a speed-up factor of two for refrigeration, so air cooled systems could achieve a clock speed in the region of 15-20nS.

COMPETITION:

Primary competitors for the ETA10 will be:

Current CRAY XMP with up to 4 processors at 8.5nS

CRAY 2 with 4 processors at 4nS; the Cray 2 offers larger memory and faster vector operatinos than the XMOP.

IBM 3090 Vector.

The current Japanese systems are unlikely to offer as significant competition as the above.

Future Cray YMP with up to 8 processors at around 6nS due to ship in 1988.

Cray 3 with 16 processors at around 2nS unlikely to ship before 1990.

IBM Summit series. No clear performance estimates are available, but Fujitsu claims 50 MIPS in scalar with their new Hawk system, i.e., 2.5 x 3090. This is probably higher than IBM will achieve, but performance in this class would make it harder for the specialized systems to penetrate IBM customers.

We expect very significant competition from the Japanese at the 1990 target date for the supercomputer program, based on their broad design effort on technology and architecture.

In addition, there will be increasing impact on the market for "conventional" supercomputers from the plethora of novel architectures entering the market, some of which will find appliction niches that are solved by general purpose systems today.

At the low end of the market, DEC is likely to join the mini-supercomputer vendors who will progressively push their performance to higher levels, while concentrating on the market below $1 million.

Even without mesurements on the ETA10 at its design speed, it is possible to get an indication of how fast its processor will perform against the major competitors. The maximum speed is not an effective indicator, because the speed of these systems can vary by a factor of 100:1 on different calculations, or on different programs that solve the same problem (see Appendix on Supercomputer performance).

Based on the performance measured at Florida State, the following competitive comparisons can be made. They show the maximum speed, minimum speed, and relative overall MFLOPS measured and projected on the 24 short programs devices by the DOE Livermore Laboratory for assessing the performance of supercomputers on their workload. These are known as the Livermore FORTRAN Kernels (LFK). The relative overall speed is a mathematical averae that is explained in the Appendix, and that has proved to be a valid basis for comparison between other systems. The first three columns show MFLOPS, the last shows the relative overall speed compred to the CRAY XMP (0.5 indicates half the speed of the XMP). All figures relate to a single processor system.

	MIN	MAX	OVERALL	RELATIVE TO CRAY XMP
CRAY XMP	1.8	188	11.0	1.0
CRAY 2	1.7	148	6.2	0.6 PRIOR TO SRAM E
CRAY YMP (est)	2.5	266	15.6	1.4
CYBER 205	0.7	160	5.4	0.5
ETA10 12.5nS	0.8	270	6.7	0.6
10.0nS	1.0	340	8.4	0.8
7.0nS	1.4	480	12.0	1.1
AIR COOLED 18.0nS	0.6	189	4.7	0.4

Note that the single processor ETA10 is PIPER, the line labelled "air cooled" estimates the slowed version. The figure of 4.7 MFLOPS derived for this system is approximately 4xCONVEX and less than 2xSCS40, both of which sell for $500K today. The ETA system would offer advantages in memory and other features, but it is expected that Convex and other systems will increase in speed by a factor of two within 12 months.

These figures are all based on the version of the LFK run by Florida State, and scaled by the cycle time as they suggest. In Livermore's own report, for example, the CRAY XMP has a harmonic mean of 15 MFLOPS, but as Florida maintains that their figures are a consistent set we have used their numbers.

These systems are too complex to be represented by a single figure, but the mean that we have used has proved a good indicator of the relative performance to be expected over a wide range of benchmarks, or in installatins that run mixed job environments.

The ETA10 shows very high peak speeds, like the 205, and should do well in the same applications as the 205, i.e., in meteorology and aerodynamics. In applicatinos that run in single precision the ETA10 gains a further factor of two.

The figures do show that there should still be concern over its performance on scalar codes. Florida State makes the point that there will be further optimization of the ETA10 compiler; on the other hand, there are also improvements in the CRAY 2, and the YMP is expected to replace the XMP during 1988; the YMP will be to the 7nS ETA10 as the SMP is to the 10nS ETA10.

Given the above performance indicators, Cray's marketing lead, their product coverage with over $100M in R&D annually supporting the SMP, YMP, CRAY 2 and CRAY 3, and their range of applications and industry coverage, it isdifficult to see how ETA could compete head to head with CRAY except in meteorology and aerodynamics as indicted above. Aerodynamics is often mixed with structurl analysis, which is less favourable to the ETA processor.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: ETA Systems (continued)

BUSINESS FORECAST:

A forecast of ETA10's success in the market is heavily dependent on several factors that have independent risk. an assessment of these is as follows:

	RISK
ACHIEVEMENT OF 10NS CLOCK IN 1987	LOW
" " 7NS " " "	HIGH
" " " " " 1988	MEDIUM
AVAILABILITY OF A FULLY COMPETITIVE OPERATING SYSTEM IN 1987	HIGH
" " " 1988	MEDIUM

Failure to meet the design goals would greatly reduce the marketability of the system. Delay shortens ETA's competitive window.

With the assumption that ETA can meet their design speed, and produce a competitively benchmarkable operating system early in 1987, we have forecast future sales as follows.

The safest market comes from the 205 base. It is likely that the ETA10 can meet the upgrade needs of those who are not going to competition. We are assuming 80% conversion success, which translates to demand for 28 systems spread over three years or nine systems/year. While these will generally be higher priced systems, several 205s were installed pending the ETA10, and the terms negotiated may yield less than full price.

In addition to upgrades, the supercomputer customer base outside Japan has been growing at a rate averaging 17 systems/year in the last three years; they are usually smaller systems to first time supercomputer users. We have assumed that during 1988-1990, ETA can achieve a market penetration equal to that achieved with the 205 against the Cray 1 and XMP during its best years, i.e., 1982-1984. In this period "T" shipped 23 against 53 systems from Cray, i.e., 30% of the total units shipped. We have not used a higher rate of penetration because many of the 205 sales were made to existing "T" customers, whereas the Cray sales were all new. This yields ETA five systems/year. "T" has traditionally been aggressive competitors in the Government, and most new sales will probably come from this area.

The new technology likely to be visible by 1990 makes this a window of 2-3 years for ETA, unless they can continue R&D to maintain in CMOS the same kind of improvement that both Cray and the Japanese plan to make with faster technologies (Gallium Arsenide and HEMT).

This summarizes to a demand forecast of 14 systems/year.

Overlaid on this are the constraints from selling, benchmarking and installing early hardware and software, even thought these costs will be borne by "T". It is unlikely that ETA could install satisfactorily more than one ysstem/month during 1988, and two/month thereafter. This gives a net installation forecast as follows:

	'87	'88	'89	'90	'91	
DEMAND UPGRADES	0	8	8	9	0	
- NEW	0	5	5	5	3	
- ΔCPU*	0	4	12	12	12	X $2M each
TOTAL	0	13	13	14	3	
CONTRAINED	0	12	14	14	3	
ACCEPTED	0	9	13	14	3	
REVENUE ($ millions)	0	138	176	177	51	

* ADD ON CPU and PERIPHERALS

The acceptance row reflects that because acceptance tests are a characteristic of this market, a delay of three months will move acceptance to the right.

The marketing of a single processor, lower cost Piper would address a lower price range, and the concept is attractive. However, a major factor in assessing whether Piper could be marketed effectively, over and above price, is the resource impact that additional volumes of lower priced systems would have on development and marketing resources until the operating system is completely wrung out. Because it is critical to be able to demonstrate performance in the users environment, benchmarking is essential but also expensive, and the effort required to benchmark a $2M system is not necessarily much less than that for a $10M system. Moreover, the advances likely from Convex (probably a factor of two in the next 12 months) makes the mean performance of Piper dangerously close to systems in the $500K range, although it has significant other advantages.

The two "cut-down" versions of the ETA-10 would have an attractive market based on their design specifications. The forecast for the Piper revenue stream is as follows:

	1988	1989	1990	1991
# of installations	16	44	46	37
# of Acceptances	12	37	45	40
Revenues - Sales ($ millions)	24	74	90	80
- Upgrades	-	12	50	60
Total Revenues (Millions)	24	86	140	140

The following assumptions are made for this forecast.

1. There is a "hot" scientific/engineering market for products in the PIPER range. The market potential will grow from 50 systems per year in 1988 to over 120 by 1989 while ETA's share of this market declines from 80% to 30% in the same period.

2. The manufacturing cost of the processor is $250,000 and the sales price is $1,000,000. There is an attached I/O, software, etc. value of $1,000,000 for each system.

3. The sales price of each system is therefore $2M.

4. Upgrades are made to installed units including additional processors and I/O.

In order to achieve the revenue levels indicated for both the ETA-10 and the PIPER ETA must achieve its design specification and an operational operating system by first quarter 1988. For both systems UNIX would be the perferred environment.

Total revenue forecast for ETA based on the ETA-10 and PIPER is:

(Revenues in $ Million)

	1988	1989	1990	1991
ETA-10	138	176	177	51
PIPER	24	86	140	140
TOTAL	162	262	317	191

By achieving these revenue levels, ETA will justify the development of the follow-on system ("Z") whose revenues are projected to cover the decline in revenues between 1990 and 1991. ETA expects to be able to develop a system with 5 times the power of the ETA-10 using CMOS enhancements.

Overall, the ETA-10 does not provide a breakthrough over the technology of its competitors. It will be a fast system when it performs to specification, and a swing factor in sales could be the desire to see survive a second U.S. supercomputer design team, and a demonstrable implementation of VHSIC technology. This sentiment is likely to improve prospects for Government orders, but are less important than other factor in determining commercial response.

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GROUP: COMPUTER SYSTEMS & SERVICES (Thomas C. Roberts, Exec. VP & President)

UNIT : Engineering Services W. Fitzgerald, President

	1987 Revenue	OP	1986 Revenue	OP
"T" Service (US)	150	+	150	+
"T" Service (Int'l)	75	+	70	+
TPM (US)	115	++	100	++
TPM (Int'l)	20	-	10	-
TOTAL	360	45	330	42

MARKET: Engineering Services provide maintenance and engineering service for "T" products (Cyber, ETA and "T" peripherals) and third party hardware (DEC, IBM, micros and OEMs). The highest growth IN 1986 came from the TPM services (15%) while "T" product services shrank slightly. In the U.S. the group employs about 3000 people and about 5000 worldwide. In July, 1987, 470 people were cut, none of them in the 1800 field engineer force. There are about 100 TPM sales people.

Engineering Services Division is made up of the following departments:

- Personnel.
- Administration (financial planning and controls, accounting, MIS).
- Marketing and sales.

- Logistics (including repair/refurbishment services).
- International operations.
- Support operations (maintenance and service planning, central hardware and software support, system product planning and management, contracts, pricidng, operations support).
- Regional operations managers.

Hardware maintenance is delivered to "T" customers via one of three methods: contractual maintenance services, noncontractual (per call) services, or special maintenance services policies (e.g., special equipment, "as-is" equipment, OEM, etc.). The majority of hardware service is performed under contract, which provides service customers with on-call response for remedial maintenance and scheduled preventive maintenance activities to be performed during specified nine consecutive hour principal periods of coverage. Customers can expect two-hour response times (excluding travel time). Customers can also contract for extended hours of coverage, provided they are within a 50-mile radius of Full Service Center.

Software support is unbundled from hardware maintenance and is offered in four levels:

- Class I - standard service agreement, including updates, enhancements, and access to the central support center.
- Class II - similar to Class I, but with reduced obligation to "T", especially with regard to successor products.
- Class III - limited coverage that does not include enhancements.
- Class IV - no support.

"T" provides access to a software problems data base called "SOLVER," which even downloads fixes if a similar problem can be found. SOLVER is available to contract customers through a toll-free 800 number. "T" supplements this offering with direct telephone support, available 7 days a week, 12 hours per day.

"T" provides a wide range of professional services to software users, including scheduled troubleshooting activities, capacity planning/performance analysis, system optimization, and system software installation, consulting, and support.

Spare parts are available from the company's world distribution center in St. Paul, MN, as well as from warehouses located throughout the world.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: Engineering Services

To notify the engineering services division of service needs, customers call a toll-free number that connects them with their regional incident management system (IMS) center. Eight IMS centers are located throughout the United States.

Customers are first asked to describe the problem and give symptoms in an attempt to resolve the problem over the telephone. If the problem is not resolved at this level, the problem is recorded into the customer's equipment history file and a customer engineer is assigned to take care of the problem.

To meet the diverse needs of its customers, engineering services is divided into these eight subdivisions: COMMA, OEM/third-party maintenance, back-up services, "T" computer systems, syntonic technology , data systems, computer facility services (CFS) and central support.

COMMA provides service and support for purchased and third-party leased IBM equipment. This service includes maintenance on selected IBM computers and peripherals, installation and relocation services, maintenance management for large multivendor installatins and consulting services on engineering changes, system improvement and hardware upgrades.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: Engineering Services

Maintenance support for a complete line of DEC systems and a broad line of Control Data OEM peripheral equipment is provided by the OEM/third-party maintenance subdivision. More than 200 products that connect to DEC systems, including Emulex, Spectralogic, National Semiconductor and Britton Lee, are serviced by this subdivision.

Back-up services allow for worldwide service for the IBM PC and XT and various peripheral products. Services consist of on-site exchange, courier exchange, ship-in exchange and ship-in repair.

"T" computer systems subdivision provides support on CYBER computer systems. Customer engineers are trained specifically for installation and maintenance of these advanced mainframes.

Small systems maintenance is the specialty of the data systems subdivision. "T" terminals, mini- and micro-comuters and equipment manufactured by Data General, Tektronix, CalComp and Zenith are supported. Customer engineers are assisted in diagnosing the problems by the central support subdivision via remote control interface.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: Engineering Services

Computer facility services assist customers in building a data processing facility, consulting, design, planning and construction management.

The syntonic technology subdivision is a U.S. mobile radio communications and electronics maintenance service and functions as a manufacturer's representative in selling, installing and maintaining 2-way mobile radio systems.

Central support provides technical and back-up support to customer engineers in the field. This technical bank is available to the customer engineers for difficult problems and is accessible through either remote assistance or emergency on-site support.

"T"'s activity in TPM began in 1973 when they purchased COMMA, an IBM systems shop set-up in 1969. In 1985, third-party maintenance became the responsibility of a new marketing group under the Field Service Division. The actual breakdwon of TPM responsibilities are by microcomputers, OEM (specifically DEC) products), and COMMA.

1985 proved to be a year of acquisition, more as a method of strengthening their OEM service capabilities than as an absolute means of overall growth. In 1985, "T" purchased four TPM firms that specialized in DEC service. There were no such acquisitions in 1986.

"T" is now concentrating on providing new, perhaps even revolutionary, service offerings. Probably the most unique offering introduced within the past year is "T"'s third-party applications software support program, targeted to users of both IBM and DEC systems. While many TPM companies would prefer to take a wait and see" attitude toward software support, "T" has pioneered software supprot that includes training, consulting, a nd telephone support as well as actual fixes. While IBM user response has been tentative, DEC users have reacted positively to this new service offering.

"T" has followed up this service offering with a special installation service where "T" agrees to install and support all hardware, systems software, and applications software for 30 days. This offering is targeted at large national accounts with remote locations and is more competitive with a similar service offered by DEC.

"T" is also exploring the concept of maintenance management at selected beta sites. At those locations, "T" agrees to service all hardwre and software, regardless of manufacturer or vendor. In doing so, "T" is subcontracting some work out; however, "T" is acting as the single point of dispatching and billing, thus providing the users with the perception of the sole-service provider.

"T" provides hardware maintenance and software support to TPM customers nationwide through 300 service locations, 50 of which are dedicated to TPM. It also offers two separte depot repair locations and one centralized spare parts facility that distributes spares through 17 district distribution centers.

Brands serviced: Britton Lee, Centronics, Cipher, Data General Data Products, Davox, DEC, Emulex, IBM, Kennedy, Ketronics, MDB, National Semi-conductor, Printronix, Scientific Microsystems, Spectra Logic, Tallgrass Technologies, and Zenith.

Since "T"'s TPM markets are concentrated in the IBM (through COMMA) and DEC systems (through its OEM group) users, it is not surprising to find that 98% of service is provided on-site. Even its microcomputer support offerings are geared toward on-site maintenance, a fact emphasized by the extremely small number (two) of depot locations. "T" also emphasizes contract service, with 90-95% of their TPM business derived from service contracts and only 5-10% from time-and-material service.

While "T" reorganized its service groups along 17 parts/service distribution districts, dispatching is still performed out of eight regional service locations, utilizing a computerized system that also tracks spare parts inventories and locations. "T" will track "T"-owned spares stored at user locations; it does not coordinate spare parts purchases through its users.

While attempting to remain competitive with other TPM service companies on a price basis, the true focus of competitiver efforts is on the manufacturers, specifically IBM and DEC. In setting service prices, "T" typically charges 12% lowr than DEC and 10% less than IBM.

An area where "T" has taken a cretive approach to providing contract coverage at a reduced price is "T"'s "backup" program for microcomputer product support. Under this program, users pay a drastically reduced (typically 25% of a normal contract price) start-up fee and then pay a fixed-price per incident charge with a ceiling of 120% of the normal contract price. In this manner, "T" provides the security of a contract, along with whatever prioritization advantage is available to contract customers, at an extremely competitive price. The user then gambles that whatever problems do occur are less costly to repair (at the fixed-price level) than the total of a normal contract.

The market for maintenance services is currently undergoing a severe price reduction based on improved product reliability. Competition for service revenues has never been stronger, particularly from the third party vendors.

"T" has an excellent service management team but insufficient attention is paid to treating service as a market, as opposed to simply providing support services for "T" products. In the TPM market, some mistakes have been made, e.g. selling service for single-site PCs which is not a profitable business and which will ultimately be reclaimed by the product manufacturer (particularly IBM).

It is estimated that the pattern of shrinking "T"-related services (due to the lack of growth of the "T" base itself and pricing pressure from the market in general) and steadily growing TPM services will continue through 1991, producing a consolidated average annual growth rate of 8% (as shown in Exhibit 1). With added emphasis on the TPM systems and peripheral markets that "T" has a substantial presence in, the TPM growth could accelerate. This would require a significant change in the outlook and strategy of the group.

Exhibit 1

Engineering Services Revenue Model

($ Millions)

	1986	1987	1988	1989	1990	1991
"T" Service U.S.	150	150	145	140	130	120
"T" Service Intl.	70	75	80	80	75	70
TPM U.S.	100	115	130	150	170	200
TPM Intl.	10	20	30	40	50	60
ETA Service*	---	---	4	12	20	30
TOTAL	330	360	389	422	445	480

*Based on projected installations.

The secret to profitable services operations lies in the control of the costs: manpower (related to productivity and service automation) and spare parts (related to the long-term availability of discounted parts necessary to support the products that are targeted for service). "T" seems to have relatively good control of most of its services operations (with the exception of the TPM PC business which is a long-term loser as a market and as a margin generator).

Both of these businesses are valuable for their revenue and profit generation capability. Both services businesses are attractive to outside buyers, particularly the TPM services which can command $1.50 per dollar of revenue. However, the captive "T" services would be difficult to separate from the Computer Systems unit.

The installed Cyber systems represent a stable and reliable base of products (ideal for the engineering service business) and the "T" peripheral market is a high-potential business that has been largely left to OEMs to date. In addition, the ETA product line represents a major revenue and profit growth channel, if and when it occurs. Separately, the TPM business is a very attractive business where the national coverage and critical mass already attained by Engineering Services play a crucial role. This is an advantage enjoyed by very few TPM service organizations. Another positive is the obvious determination of management to cut costs through the elimination of wasteful overhead while retaining the engineering force intact.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: Engineering Services

The service market has become very competitive and is currently undergoing heavy price pressures. This applies equally to the captive "T" service as well as the TPM service activities. In addition, the "T" product base is not growing which, allied to the erosion of prices, accounts for the shrinkage in the revenue volume and the need to downsize the staff.

Last Updated: 08/10/87

GROUP: COMPUTER SYSTEMS & SERVICES (Thomas C. Roberts, Exec. VP & President)

DIVISION: Professional Services (PS) Gary Guardia, Vice President

BUSINESS:

Professional Services provides consulting support to the Company's computer businesses. Its capabilities include software installation and maintenance, systems integration, systems, analysis and customer application development. Professional Services also provides human resources consulting and services.

These services are chiefly provided in connection with "T"'s computer systems.

PS provides pre-sales support often a "packaged" price approach for activities such as needs analysis. This was performed by the Computer System group and has been "recaptured" by PS. This and work performed for other units such as SIS is charged on a transfer price basis.

The unit is entering the integration market. It recently obtained a $13.7 million integration contract at Wright Patterson Air Force Base. This is a logistics system which interconnects disparate equipment, largely UNIX based. There is little if any "T" equipment.

DIVISION: Professional Services (PS)

PS has an overall staff of 2000 analysts, programmers, and engineers, with 800 in the U.S.

PS also sells some software products that run on "T" systems. An example is the applications software from TRES Systems of Dallas:

- TRES Systems was founded in 1969 and acquired by "T" several years ago for about $12 million.
- Half of its business is consulting and half is software products.
- EIS/2000 is an on-line, human resources package.
- Customer Information System (CIS) is a set of software for utilities. "T" is currently negotiating sale of the marketing rights to this product.

Particular areas of expertise of PS staff reflect the relationship with "T"'s standard market: modelling/simulation, linear programming, pattern analysis, graphics, data communications, information engineering, image processing, CIM, structural engineering, operating system maintenance, performance analysis, artificial intelligence and robotics.

Most of the business cannots of contract programming in FORTRAN on applications in the above lost.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: Professional Services (PS)

This division used to include industrial training using PLATO-based systems. This business has been moved to the Training and Education Group.

The division is alternating more into higher value-added systems integration but this is difficult given the isolation of "T"'s systems and the lack of expertise in other vendors' systems.

The "body-shop" business is entering a commodity phase and much of PS' business would fall into this category. PS is somewhat protected as it is a unique source of "T"-trained people and also of scientific and technical programming expertise.

Prime opportunities with this group are to concentrate on support of target industry applications areas, such as electric utility and electronic design integration. Emphasis should be placed on adding integration capabilities with other vendors' system. This is a key group for conversion from NOS to NOS/VE and from the CYBER to succeeding platforms. There will also be PS opportunities related to supercomputers, including for CRAY systems.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: Professional Services (PS)

This division is strategically important to "T"'s Computer Systems Division.

RESULTS:	1987 Revenue	1987 OP	1986 Revenue	1986 OP
	119	12	116	11

MARKET: The market for this unit is that of systems analysis and design, software development, consulting, software installation and systems integration in support of "T" and other manufacturer systems. This includes the energy management systems (but excludes the CIM activities which are nevertheless systems integration-related). It consists primarily of contract services (body-shop) of FORTRAN programming. The unit also does packaged pre-sale support such as needs analysis. Recent activity includes systems integration for non-"T" products (UNIX based DOD logistics system). There are approximately 800 people in the US in this unit.

External Factors: There is enormous potential and growth in the systems integration market at present. A similar group in IBM is the fastest growing business IBM has. The body shop market, however, is entering the commodity market phase where pressure on prices will drive down margins. "T" may be shielded from this to the extent that they are the prime source of "T" trained people and can therefore charge reasonable rates that are not subject to much competition.

Internal Factors: "T" has recognized the need and has begun to enter this market. There is as yet incomplete understanding of the investment requirements in core products, business process emphasis as opposed to System solutions, and marketing/sales drive that are the prerequisite to success in the systems integration market.

GROWTH: The market for systems integration is exploding, but "T" cannot hope to participate in the entire opportunity because of its narrow emphasis on utilities and manufacturing systems that are "T" product-based. This is a severe limitation since 85% of the market is IBM/DEC based (for which the people skills are lacking). This limits the growth to the degree that "T" systems are sold.

STRATEGIC ASSESSMENT: The best profit opportunity with this group lies in leveraging the skills inventory with high-level business analysts and concentrating the thrust on business solutions rather than systems solutions. The danger is that the distinction between the body shop business (systems solution) and business solutions will not be clearly perceived with the consequent impact on margins. The business solution market, is thinly populated, with the competitive emphasis on assumption of responsibility, responsiveness and performance, commanding better margins.

POSITIVE FACTORS: This unit represents a skills inventory that is fairly unique (and a customer base that is also). Its value lies entirely here. As such it would be desirable to Big-8 accounting firms (particularly AA, Peat/Marwick,Coopers & Lybrand) and the leading professional services firms including EDS, BDM Int'l, CSC and others involved in the government, scientific and engineering markets that PS serves.

NEGATIVE FACTORS: As mentioned earlier, there has been no effort to concentrate all of the professional services and systems integration capabilities under a single direction. Ideally it should be here. Also, this group should be used as the tool for overcoming the current users fear of NOS to NOS/VE upgrades. It would be long-term beneficial for many parts of "T"'s business.

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GROUP: COMPUTER SYSTEMS & SERVICES (Thomas C. Roberts, Exec. VP & President)

UNIT : International:

Europe	Thomas Miller, Vice President
Pan Am	Emmanuel J. Otis, Sr Vice President

INTERNATIONAL:

International operating revenues were $1.013 billion in 1986. The attached tables represent an approximate breakdown of these revenues.

MARKET:

The Europe and Pan Am units sell and support "T" products in 47 countries. While commercial sales are down in the US, they are growing overseas. The unit is doing well in Europe (particularly West Germany, France where a profit of $5M was achieved in 1986, and the UK) and in Taiwan and Korea. There are approximately 2000 people in Europe.

Over $50 million was out of overhead for international in 1985/86.

"T" has signed an 8-year computer accord with India. Electronics (India) will jointly develop computers with "T". The 8-year agreement includes the construction of a special unit at Hyderabad to manufacture CYBER 180 medium powered computers. Total manufacturing output is estimated at over 500 systems over

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: International

the life of the contract. Electronics' employees are being trained in production and marketing of the computers. Meanwhile, Electronis will import 12 completed machines from the U.S. while building the Hyderabad unit.

1986 Revenues ($ Millions)

Group	U.S.	Int'l.	Total
Computer Systems	815	481	1296
Government	300	42	342
Data Storage	681	365	1046
Business Services	400	45	445
Training and Education/Ticketron	138	80	218
TOTAL	2334	1013	3347

Computer Systems	U.S.	Int'l.	Total
Hardware	325	325*	650
CIM	80	20	100
Professional Services	60	56	116
SIS	100	---	100
Engineering Services	250	80	330
TOTAL	815	481	1296

* International Computer Systems includes SYSTIME which had revenues in 1986 of approximately $25 million.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: International

Government Systems

International revenues of the Government Systems group include revenues of the Canadian operation in Ottawa and revenues from defense departments of foreign governments for systems such as AN/AYK-14. Orders for the latter are often placed through the U.S. Government.

Revenues of the 49% owned CDL in the U.K. are not included.

Data Storage

Partners in MPI are Honeywell-Bull and Bull. Their markets for data storage products from "T" are primarly outside the U.S. Furthermore, approximately 50% of "T"'s data storage captive systems are used interntionally. Therefore, it was assumed that 80% of captive Data Storage revenues were interntional.

Of the OEM business, approximately 25% is international.

Total Data Storage international is

80% Captive = 0.8 x 185 = 150

25% OEM = 0.25 x 860 = 215

TOTAL = 365

DIVISION: International

Business Services

Only a significant part of Business Services international revenues is MICROGNOSIS which was based in London before its headquarters was transferred to the U.S. Other banking services and financial services are used in Canada.

Training and Education/Ticketron

Ticketron has revenues in Canada for its wagering and ticketing services, assumed to be $30 million in 1986.

Training and education has approximately $50 million of international revenues, largely through CDI activities in Europe.

Therefore, 1986 revenue breakout is:

($ Millions)

	U.S.	Int'l.	Total
Ticketron	95	30	125
Training & Education	40	50	90
Health Care	3	--	3
TOTAL	138	80	218

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: International

1986 International Revenues by Geographic Area

Country	1986 Revenues ($ Millions)
Europe	
West Germany	130
France	120
U.K.	110
Italy	10
Bevelux	30
Scandinavia	20
Switzerland/Austria	5
Other European	15
TOTAL	440
Captive Data Storage	150
Canada	100
Pan Am	320
TOTAL	1010

Total number of country markets is 47.

In the US, the market for processors has begun a digestive pause as users attempt to make better use of the systems already installed (interconnection, networking etc) and delegate the purchasing power and authority to the operational units (departmental processing) rather than adding to the central facility. This has already occured in the US and will ultimately occur in the international markets too.

Unlike the US market,"T" has sold successfully in the commercial market (e.g., Banks in France- where 1986 revenues were up 22%, the Danish Post Office, etc.). This has generally happened because of the self sufficiency and initiative of the local managers rather than corporate directives and leadership.

The growth of sales and the profitability of these units has offset much, though not all, of the losses of the corresponding US group. The emphasis can be expected to continue on the midrange products in the immediate future, with some success in the 990 models which are already selling.

The most significant contributions to revenue and profitability of the international units would be (a) improve the competitiveness of the products they have to sell and (b) broaden the scope of the product lines by including non-"T" products in the spectrum (e.g., ETA, Sun Microsystems, Korean low-end products) that have direct relevance to the skills of the sales force.

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GROUP: COMPUTER SYSTEMS & SERVICES (continued)

DIVISION: International

Both the European and the Pan Am groups have value for their field sales and support capabilities which have driven the business despite less than satisfactory software and hardware availability. The cost of duplicating this capability for a new entrant would be exhorbitant.

The principal negatives concern the shallow penetration achieved in most markets serviced. Only in a few countries, such as Taiwan, has the beneficial effect of critical mass been felt. It is nevertheless surprising what has been achieved given the circumstances.

Last Updated: 08/11/87

GROUP: COMPUTER SYSTEMS & SERVICES

DIVISION: Systime

Systime is 98.5% owned by "T". In 1985, Systime had $55 million of revenues. This was reduced to about $25 million in 1986 and is running at an $18 million rate in 1987. Most of the reduction was due to selling off and closing down activities including a DEC service function.

It has a number of UNIX based products.

- 2 x 286 based systems, lowest cost $5K.
- 1 x 386 based system.
- An 8 MIPS CCI system which costs $250K.

It provides added value software from $10K to $330K. Systime has a sales force of 30 and a VAR network. Ten/fifteen percent of its revenues are international through VARs and sales agents in secondary contries.

Systime specializes in retail and manufacturing applications.

In 1986, it was transferred from a reporting viewpoint from "Other Services" to "Computer Systems".

GOVERNMENT SYSTEMS GROUP

Last Updated: 08/10/87

GROUP: GOVERNMENT SYSTEMS GROUP (GSG) (Boyd Jones, President)

PRINCIPAL DIVISIONS:

- Government Systems(GS) US Operations Roger Handberg VP
  - GS Manufacturing Division, Gary Buakant GM
  - GS Aerospace Techn. Dev. Div., Duane LaFortune VP
  - GS Information Sciences Div., Gale Allen GM
  - GS Technology Center, Robert Lillestrand, VP
  - Financial Plans & Controls, Daniel Dolan, VP
  - GS Marketing, Terry Petrzelska, VP
  - GS Program Planning & Dev. Don Lemke, GM
- Computing Devices Co (Can), Jack Fawcett, President
- Computing Devices Ltd (UK) 49% owned by "T", William Uttley-Moore, GM
- SIS (Government only), (Frank Shimkus, Dir.)
- VTC (subsidiary)

BUSINESS:

GSG is a major supplier of standard military computing hardware, software and services for the Department of Defense, NASA, several other federal agencies and certain friendly nations. GSG will continue as a major supplier of standard military computers and peripherals. In addition, it is moving toward an electronic systems integrator role to become a prime government contractor in this area. It is also capitalizing on its position as the prime contractor responsible for developing new software technology that allows the U.S. Navy to program efficiently in the Ada computer language. GSG is leveraging its position in the forefront of very high speed integrated circuit (VHSIC) technology.

International markets include US forces abroad, (e.g. European Command, US Army) and friendly governments (predominantly UK and Canada, but also including Belgium, the Netherlands,Denmark and Taiwan). Sales outlets include local "T" offices, own direct sales staff and sales agents.

In 1986, revenues were $341.6M, up 4.4% over 1985. During the year, GSG obtained the lion's share, (80%) of the production contract for the AN/AYK-14 and a three-year contract for the M-1 Tank Fire Control computer, the only digital computer in this vehicle. Training and education revenues in this group were $15M in 1986 and SIS Government Services $ 58.4M up 6%. (SIS revenues are included totally in the SIS unit revenues.)

GS 1986 revenue distribution is as follows:

	($ Million)
Sales of standard "T" systems from Computer Systems Unit (Based on $100 million of sales with $40 million passed through to CS for manufacturing)	60
Computing Devices Company (Canada)	10
Military Systems	
AN/AYK-14	110
UYH-3 and other disks	50
Signal processors	50
Education and Training	15
Other	45
TOTAL	$340

"T"'s profit was affected by project overruns in 1986 and also 1987. Profitability should improve in 1987 with the resolution of these problems. In 1986, "T" sold a majority interest in its British subsidiary (CDL). Profit on the sale was off-set by increased technical expenses - thus profit remained the same in 1986 as in 1985 despite increased revenues. GS has been profitable in each of the last seven years.

The GS unit as a whole is separable from "T" with the possible exception of the Information Sciences Division which concentrates on selling other "T" products and services, especially from the

Computer Systems division. The GS manufacturing plant is self-contained next to the HQ in Minneapolis.

However, divisions in GS are not separable they are more properly cost centers than profit centers. Thus, the unit should be addressed as a whole.

"T"'s GS growth will come:

- Continued growth of base production contracts with enhancements.
- New opportunities for second sourcing.
- SDI and intelligence business growth.
- Increasing orders for high margin spare parts on AN/AYK-14, UYH3 and M-1 programs.
- Signal processing computers.
- The completion of the 600 ship Navy will shift the key to growth in Navy programs from new to upgrade programs.

Management has indicated a desire to reach $1 billion in revenues in 1991. To achieve this "T" will need product improvements and new products, specifically under UNIX and Ada. New software initiatives spurred on by the Navy's Advanced Language Systems Development project (with SofTech) and test computers for the TRIDENT program support this development.

Currently, non-DoD systems integration is handled by the Professional Services group - a mistake due to the very specialized nature of procurement cycles and bidding procedures that have nothing in common with the commercial services that are the bulk of the business for that unit. There is potential for a concerted drive to gain government systems integration contracts, but it requires a specialist staff (which are readily acquirable).

GSG is suffering slightly from cost overuns for several R&D-type contracts. However, this can also be regarded as buying in to future production contracts, so that it is more of an investment than a loss. Much of GSG's products on the hardware side are platform-sensitive (i.e., there are only so many aircraft/ships to equip). But the speed with which today's military systems become obsolete suggests that this aspect will not be a significant factor.

GS is "not around when you talk systems integration" according to the industry. It is a "box supplier": a good group of engineers. Other SDI vendors do not see "T" as a major player. Thus, "T" has a long way to go to change its image and penetrate new markets.

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GROUP: GOVERNMENT SYSTEMS (continued)

DIVISION: Government Systems Manufacturing, (Roger Handberg, VP)

Rapid technological change is encouraging DOD suppliers to form cooperative agreements for research, development and marketing of leading-edge products.

"T" and the Boeing Electronics Company have formed a cooperative effort to design, develop and market a family of spacecraft computers for on-board sensor data processing. The 1750A spacecraft computer "T" introduced in 1986 will serve as the control processor for system operations. Combining the Company's space computer expertise with Boeing's experience in applications and systems engineering makes "T" a player in the growing Strategic Defense Initiative (SDI) and satellite data.

"T" has also joined with SofTech to develop the Navy's Advanced Language System Machine and with Northrup for ATARS (Advanced Tactical Reconnaissance Systems) for Air Force manned and unmanned aircraft.

All future military systems will use VHSIC technology for compactness and reliability. "T" has a foot in this via door via VTC.

"T" is viewed by competitors as a niche player.

The unit will need to coordinate its marketing, support and professional services better. The civil agencies marketing unit now operates decoupled from the other marketing units with a corresponding loss in joint capability utilization.

Growth in this unit is impeded by Gramm-Rudman-Hollings only to the extent that "T" hardware programs are affected. Outside of this hardware dependency are other, high-growth markets that relate to manpower (professional services, systems integration, education and training) and software products and services. This has not been a "T" strength in the past but must become one in the future otherwise revenues will fall. Lack of low-end computing devices and the absence from the embedded computer market (until the M-1 task award) have stifled government systems penetration.

The principal products of GS are computer systems designed to military specifications and related hardware and software. GS actively seeks government contracts for research and development efforts on projects for future military products which it believes may be designated as standards for the military services. GS currently produces the AN/AYK-14, the U.S. Navy's standard airborne mainframe computer used for fire control, navigation, mission command and control, and anti-submarine warfare. A large portion of GS's revenue is from the AN/AYK-14. In 1986, GS obtained contracts for 80% of the competitive production contract for this system.

About 6 months ago, Unisys lost a follow-on contract for AN/AYK-14s to "T". This will make Unisys very competitive on the next contracts. Every year there is a new bid - there will be very tough price competition on the next ones.

In 1986, "T" had a problem with the P3I (Pre-planned Product Improvement) enhancement to the AN/AYK-14 which will account for about 20% of expected AYK-14 revenues in 1987. The problem related to machine performance under a spefific condition on Grumman aircraft. The problem has been solved and deliveries and payments were uninterrupted.

GS also produces the U.S. Navy's standard disk drive, the AN/UYH-3, which is used on Navy ships. GS is the prime subcontractor for the fire control computer that is used in the U.S. Army's M-1 tank. Other important products include an airborne and ground-based radar signal processing system, anti-submarine warfare systems and, through a U.K. affiliate, airborne reconnaissance systems and stores management systems. GS is also under contract to the U.S. Navy to develop Navy-wide software and desgin standards to facilitate use of the Defense Department's Ada computer language.

In 1986, GS sold an estimated $50 million of advanced machines for special purpose application for secured intelligence operations. This involved Tempest conditioning of CYBER mainframes. Also, in late 1986 GS obtained a classified $29 million order for mainframes.

Competition is strong for defense and space-related computer business. Currently, IBM and Unisys Corporation are the principal competitors for the military computer business. The federal government's policy of requiring second sources for its major production procurements increases the competitive pressure. To the extent there is second-source competition, revenues and margins may decline. However, the requirement for second sources may increase opportunities to bid for contracts previously sole-sourced by competitors.

GS's business is strongly affected by changes in the US defense budget. Reductions in the defense budget, such as may result from Congressional budget-balancing efforts, may adversely affect this unit's growth in revenues and profits.

The unit's profit is currently wedded to cost control in manufacturing operations and to production cycles/learning curves. A higher proportion of systems integration and professional services would dampen this oscillation but tend to reduce margin growth, since the latter command lower returns.

Professional services are also essential for rebuilding "T"'s early warning network for new federal applications. "T" does not have the critical mass to compete with Ford Aerospace, Hughes, IBM, UNISYS etc in other than specialized hardware markets and currently not at all with EDS, CSC, IBM etc in the professional services markets.

"T" has long been penalized by an insistence on centralized management: key executives who preferred to operate close to major agency clients were dropped over the past three years. Terry Petrzelska, previously a key force in Air Force programs , was rehired to defense program planning and has been successful in broadening the focus (away from a concentration on Navy) and in improving the image of the Technology Center by obtaining involvement in USAF research and development ($135 million of obligations in 1986).

GSG is well positioned in a sellers market, has a good image as a supplier of quality products, is in the mature phase of three major programs and has begun to move into the second-source market for competitor products (e.g., for the Sperry signal processor).

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GROUP: GOVERNMENT SYSTEMS (continued)

DIVISION: Aerospace Technology Development (ATD) Division
Duane LaFortane, VP

Government Systems ATD Division provides research, study and design services in connection with various government-sponsored research and development projects. These projects include the design and development of successors to the AN/AYK-14 and airborne signal processing systems. Study contracts are also under way for the Strategic Defense Initiative and NASA's Space Station Program. Computer-based training is provided to various armed services branches.

The key "T" markets are NASA, Air Force Aeronautical Systems, Naval Air Systems Command and DoD Space Command. The legacy of Navy standard airborne systems is beginning to support new efforts in avionics, tactical reconnaissance, space-borne computers and sensor platforms, battle management/command, control, communications and intelligence technologies (of SDI with Air Force). NATO programs include Air Command and Control System (AMS Consortium) and Northern Naval Command System. "T"'s success in airborne systems in competition with Honeywell and Hughes appears to be motivation for partners to explore "T" relationships.

"T" is in the fabrication stage of a $14 million development contract from the Army's Strategic Defense Command to build a "supercomputer in a minicomputer package" for use in the Strategic Defense Initiative (SDI) program and other Department of Defense applications.

GS is developing a powerful 32-bit Militarized Computer Module (MCM) using advanced 20,000-gate, Very High Speed Integrated Circuit (VHSIC) technology. The contract calls for demonstration of multiple MCMs in a network configuration in late 1987. Networks of MCMs will handle complex ballistic missile defense data processing requiring hundreds of millions of instructions per second. This MCM technology will be used in new SDI and Department of Defense programs requiring the power of 32-bit processors.

LaFortune has worked closely with Petrzelka and the latter's in-depth knowledge of SDI and Space Command will help plans to turn GSG away from AN-AYK type production and its endless modifications.

All of the programs being addressed have a high level of probable funding, but perhaps at a somewhat slower rate of growth than previously projected. All except SDI initiatives have bipartisan Congressional support. Team selection will be crucial to continued success in this market area.

This unit's profit will not improve in the short term because most of the development programs are cost-plus low risk contracts with government-limited profit levels. Out-year prospects are good if the current and proposed contractor teams maintain relationships. It has several leading projects that could assure increase of its market share.

LaFortune has attracted a number of talented people from within and outside of "T" - a move considered essential to "breaking out of the 'T' mode." Hanley Feldman, Manager of Advanced Technology Programs, and Richard Simson, Manager of NASA Programs, are qualified and accepted as leading proponents of a new "T" image in their business sectors.

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GROUP: GOVERNMENT SYSTEMS (continued)

DIVISION: Information Sciences Division (ISD), Gale Allen, GM

MARKET:

ISD focuses on the non-mil-spec, non-ruggedized applications of "T" products and professional services in the federal marketplace, with principal focus on NASA, DoD laboratories, Energy and science elements of Commerce. In past, this unit applied products and software from the commercial groups to agency problems, including supercomputers. This unit accounts for less than 20% of current group revenues.

"T" image as a complacent niche marketer applies most directly to this division. Loss of previously sole-source scientific and engineering computer center upgrade projects to UNISYS, Cray, Amdahl, and even, recently, to DEC high-end machines revealed an inability to recognize the technical advantages of competing machines. Gramm-Rudman-Hollings and the Tax Reform Act are expected to heavily impact growth in this market through at least 1988.

Management uncertainty, retention of old-line "T" approaches to solution of new processing problems and the slow acquisition of new professional services talent have hampered plans to improve this unit's market posture.

New management is clearly indicated, but no signs have appeared of imminent change.

ISD has little prospect of major growth unless its competitive strategies and staff mix are substantially upgraded. Manpower deficiencies are considered the major road block.

Aggressive pricing and lower mark-up appear essential to recovering earlier growth rates, but this will produce somewhat reduced profit levels. Most profitable effort in the past has been the remarketing of modified standard products for client requirements. Development of interface hardware or custom software usually resulted in bid levels that were sufficiently competitive.

The value of this unit is in its leverage of existing commercial offerings, but management of this division is a significant challenge, since it integrates hardware, software and professional services perspectives, while demanding detailed knowledge of the entire "T" line. "T"'s product span is seen as inadequate and delayed at the mid to upper range (this altitude is probably changing with new announcements and deliveries. "T" gets high marks for service and the quality of its staff. It is not aggressive in non-DoD areas and in pricing.

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GROUP: GOVERNMENT SYSTEMS (continued)

DIVISION: GS Technology Center - Robert Lillestrand, VP

MARKET:

This unit addresses both new information processing and applications technologies with emphasis on scientific and engineering problems. Support has been divided between federal applications of ETA-10, special intelligence processing projects and advanced vehicle platforms (space station, new space shuttle, supersonic military aircraft). Efforts are just beginning to analyze new ways of overcoming erosion of the 205 and 800 machine markets in the defense scientific and laboratory communities.

VHSIC technology, Ada software applications, ultra high-speed parallel processing and adaptive/artificial intelligence machine prospects do not yet have any clear leader. All mainframes, including IBM, are struggling to gain an edge in these market segments, competing with universities, super-mini hardware developers and new foreign developments.

The intensive effort required to complete the ETA-10 project drained some of the high-tech talent needed for the federal government markets. Unless the ETA experience can provide applicability to emerging federal projects, this unit may lose valuable experience in early development programs.

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GROUP: GOVERNMENT SYSTEMS (continued)

DIVISION: GS Technology Center (continued)

Potential of this market is good, but unit may not reach expected growth rates as a result of required ETA investment and fading "T" image in government market as a leading engineering and scientific processor developer.

This unit is not expected to be profitable, since it is an essential element of future programs of the Aerospace and Manufacturing Divisions. Measures of effectiveness are difficult to apply since much of the past effort has gone toward the supercomputer project.

The unit includes an equal mix of older and newer technical talent. It could not survive on its own, but could be combined with new manufacturing and development facilities for advanced information processing product lines.

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GROUP: GOVERNMENT SYSTEMS (continued

DIVISION: Computing Devices Company (Canada)

This small unit was in severe trouble in the 1983/84 time frame. It spent most of its time in litigation - since it had underbid and over run many projects.

It is now restored to health and is winning follow-on and some new contracts. In 1986 it completed, for example, an $8 million contract from the Canadian Department of National Defense for 66 military-specification artillery computers and associated spares. This was a follow-on order to a contract awarded in 1982.

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GROUP: GOVERNMENT SYSTEMS (continued)

DIVISION: Computing Devices Ltd. (U.K.)

Formed in 1982 as a wholly owned "T" company at Hastings, Computing Devices now enjoys majority British ownership and thus the independent status necessary for the commission of futher government defence work.

Its airborne weapon management systems, based on advanced digital electronic techniques, are now flying in such aircraft as the Hawk, Tornado, Jaguar and Harrier.

The sophisticated SMS 4000 series, designed under internal company funding for NATO, has pioneered the concept of interoperability of all future airborne weapons across all existing and future aircraft within the Alliance. And the Company now has a US government contract to study application of this concept to American aircraft.

Ground-based weapons, stores management systems, real time reconnaissance management systems, airborne and ground-based image processing equipment and airborne computers and database controllers are other leading edge Computing Devices Company technologies.

At the end of 1986, CDL employed 200 people and had 1986 revenues of approximately 20 million pounds. It now has over 300 staff and expects to have 400 at year end.

As majority ownership was transferred in 1986, CDL revenues are no longer included in "T"'s reported revenues. Participation is reported on an equity basis.

Last Updated: 08/10/87

GROUP: GOVERNMENT SYSTEMS

DIVISION: VTC, Inc.

In competing for contracts, GS needs a supply of specialized integrated circuits. To obtain a more rapid and assured source of supply of these circuits, in 1984 "T" acquired a 46% interest in VTC, Incorporated.

VTC designs, develops, manufactures and markets custom, semi-custom and standard integrated circuits. It developed and produces very dense, bipolar circuits with high-speed, mixed digital logic and analog functions. VTC is also developing an advanced 1.25 micron CMOS circuit with radiation-hardened capabilities for digital logic functions.

Currently most of the integrated circuits VTC produces are sold to "T" for incorporation into products manufactured by Government Systems, Data Storage Products, and Computer Systems.

"T"'s investments in and advances to VTC as of December 31, 1986, were $55.2 million. VTC is expected to require significant additional funding over the next two years.

In May, 1987, "T" announced the acquisition of the 51% of VTC owned by its founders and employees. VTC was formed from the micro-circuits division of "T" which was bought by VTC in 1984.

DATA STORAGE PRODUCTS GROUP

Last Updated: 08/11/87

GROUP: DATA STORAGE PRODUCTS GROUP (DSPG)
(Larry Perlman, Exec. VP & President)

Offering a broad range of high-performance, high-capacity magnetic data storage products to computer systems manufacturers around the world, DSPG is the largest supplier to its target market and accounts for more than $100 million worth of magentic tape and optical disk drives that are developed and manufactured by Laser Magnetic Storage International, a company jointly owned by "T" and N. V. Philips.

The organization of DSPG is shown in the attached chart.

BUSINESS:

DSPG sells to original equipment manufacturers (OEMs) high-performance, high-capacity, rigid magnetic disk drives and related components developed and manufactured by a joint venture it manages. It also sells magnetic tape drives and disk drives based on optical technologies that are developed and manufactured by an affiliated company. It is the world's largest supplier of high-performance, high-capacity data storage devices to OEMs. DSPG also owns development and manufacturing facilities for magnetic media production, and has investments in other affiliates. Revenues of DSPG were $1,045.6 million, $1,269.1 million and $1,543.0 million in 1986, 1985, and 1984, respectively. Over 25% of FYE 1986 revenues were from international.

DSPG sells disk and tape drives through a direct sales force with over 250 sales representatives and through distributors to OEM customers worldwide. During 1985 and 1986, DSPG reduced its product lines from 14 to 7, all concentrated on the upper end of the data storage market.

Magnetic Disk Drives: Disk drive research, development and manufacturing operations are conducted by Magnetic Peripherals, Inc. (MPI), a joint venture owned by "T" (75%), Honeywell Information Systems, Inc. (14%), Unisys Corporation (5%), and Bull Systems S.A. (6%). DSPG manages MPI. In March 1987, "T" agreed to acquire Unisys' 13% interest in MPI over approximately a two year period: 8% was taken up immediately and "T" has an option to acquire the remaining 5%. Under the agreement, Unisys has committed to purchase disk drives from DSPG on an OEM basis for a two year period. "T" is discussing with the other MPI partners whether further modifications to the structure of MPI would be advantageous.

Disk drives are produced by MPI based on orders from its venture partners, which are the exclusive purchasers of its products. "T"'s purchases from MPI include products sold to OEM customers through DSPG, as well as drives purchased by "T"'s Computer Systems and Services Group. Sales of magnetic disk drives to OEM customers accounted for approximately 75% of the revenues of DSPG in 1986.

MPI manufacturers rigid disk drives in 5.25", 8", 9", and 14" diameter sizes. Current production in these four product lines is comprised exclusively of devices which are both high-capacity (storing more than 48 megabytes of data) and high-performance (accessing data in less than 40 milliseconds). The product lines are:

5.25" Drives: The Wren 5.25" rigid, non-removable disk drive line includes both full-height and half-height products. These drives are used in mini- and microcomputer systems that require large amounts of storage capacity, such as engineering workstations. Current production models store from 48 to 300 megabytes of data. A higher capacity full-height Wren IV and a half-height Wren III model were added to the line in 1986.

8" Drives: Two new models in the EMD 8" module drive product line were introduced in 1986, one storing 491 megabytes of data, the other 736 megabytes. These and the original 368 megabyte unit are used in multi-tasking, multi-station computer systems in office network environments, and all feature an 18 millisecond seek time. Volume shipments of all three models are being made in 1987.

9" Drives: Several models of the FSD 9" fixed, rigid disk drive store from 300 to 516 megabytes of data and fit in half the width of a standard 19" minicomputer rack enclosure. Volume shipments commenced in 1984. A companion product, the RSD, provides 80 megabytes of storage capacity on removable recording media.

14" Drives: In 1986, a new model with 1300 megabytes of data storage was added to the XMD line of 14" fixed, rigid disk drives. Other models in the line store 825 or 858 megabytes of data. These drives provide some of the highest single-rack data capacities available to the OEM computer industry, and feature a data transfer rate of up to 3 megabytes per second. All XMD drives are in volume production in 1987. Also in 1986, DSPG announced its Hydra 14" disk drive with a storage capacity of 703 megabytes of data, and a data transfer rate of up to 12 megabyte, per second which is among the fastest in the industry. In addition, "T" offers the SMD, a 14" drive with a removable disk pack that stores either 80 or 300 megabytes of data.

DSPG has more than 700 active accounts worldwide for its disk drive products. Principal customers include many major microcomputer, minicomputer and mainframe computer manufacturers.

DSPG is the world leader in OEM, non-PCM 14" drives (flat market) and in 9" drives (the main area of quality and yield problems which may not be completely resolved). In the 8" market Fujitsu leads but the market is tending to be usurped by the higher performance 5.25" drives where DSPG leads along with Micropolis and Maxtor. DSPG has just announced a new 8" drive (750MB, 16 millisecond access time) but is not a player in the low performance 5.25" market.

Magnetic Tape/Optical Drives: In August, 1986, N. V. Philips of The Netherlands and "T" formed a new company, Laser Magnetic Storage International (LMS), to develop and manufacture mangetic tape drives and disk drives based on optical technology. LMS is owned 51% by N. V. Philips and 49% by "T". It includes the tape drive operations formerly conducted by Computer Peripherals, Inc., which was a joint venture of "T" and NCR Corporation, and the optical disk drive operations of Optical Storage International, a partnership of Philips and "T".

MARKET:

The market is subject to rapid technology changes to the point where price/performance ratios are cut in half every two and a half years. Success is dependent on product quality and competitive manufacturing costs. Vendors are marketing products before adequate testing has been done to gain market share and competitive edge.

1) Disk Drives: This market was worth $15B worldwide in 1986. It is estimated that IBM has 45% of this for its own systems (captive). The non-IBM portion consists of other captive, PCM (plug-compatible manufactures) and OEM revenues. The OEM portion was $4 billion in 1986 and will grow to over $5 billion by 1989. The total market is expected to grow at 15% per year through 1989 and has the following characteristics:
   - The non-IBM captive and OEM markets are expected to grow at a lower rate.
   - The captive market served by DSPG will trend down because of the Unisys exit.
   - The OEM market addressed by DSPG will grow at 8%.
   - Growth rate outside the US will be higher than within.
   - Unit growth will be higher than revenue growth.
   - Small drives will grow fast, except for IBM and compatibles, large drives will decrease.

These factors will put continued pressure on cost reduction to achieve/hold profitability. DSPG has recently lost one of its captive customers (Unisys/Sperry) although it will stay as an OEM customer over the next two years while Unisys changes over to its old Memorex facility. Optical storage growth will be high in image processing applications but will not replace magnetic storage in DP applications.

"T" is the only OEM supplier of 9" and 14" removable disk drives. DSPG has a large parts business ($65 million in 1986) and has a 20% market share in OEM disk drives. Except for Seagate no other competitor has as large a share (Seagate is roughly equal). Fujitsu, Hitachi, Micropolis, Miniscribe, Maxtor, Seagate, Toshiba, Priam, and Quantum are the principal competitors. The following is a forecast of worlwide OEM revenues (as per Disk/Trend):

	1985	1986	1987	1988	1989	
Sales ($M)						
US	1912	2566	2899	2980	3060	
Non-US	1145	1436	1707	1932	2084	
Total	3057	4002	4606	4912	5144	8% AAGR

2) Optical Disk Products: LMSI has an 18-20% share of the optical drive market. The total market shipments for these products is estimated to be $400M in 1987 and increasing to $1.5B by 1991 (Rothschild). Principal competitors for LMS in the optical storage field nclude several large Japanese manufacturers. Within the next few years, LMS plans to

introduce variations of the LaserDrive 1200, and to introduce the LaserDrive 500 series (5.25" WORM) to be sold in the personal computer market. LMS plans to introduce the 5.25" laser storage unit in late 1987 or early 1988. Japanese and domestic companies currently are developing 5.25" products, and are expected to be very strong competitors. LMSI's position in price/performance is competitive with Hitachi (market leader) Optimem (subsidiary of Cypher Data) in 12". It is expected that its 5.25" will also be competitive. More revenue is expected from 12"; more units from 5.25". Sony is forecast to ship eraseable optical 5.25" drives in 1988, but this technology is still unproven.

Optical technology has certain advantages over magnetic technology, as well as application capabilities not now met by magnetic storage, that could lead to the development of a substantial market for optical disk drives in the long term. These advantages include far greater capacity, lower cost er unit of storage, data portability and greater stability of stored data. Anticipated uses for optical storage devices include low-cost duplication and distribution of software, long-term storage of text and images (archival) and backup storage applications. After many years of development and false starts, optical storage technology is now emerging as a high growth application field. It will be the electronic file in Office Automation. Filenet, one of the few pure plays, has just gone public with a valuation of 4+ times revenues.

3) Magnetic Tape Drives: LMSI's magnetic tape subsystems were transferred in 1986 from "T" and include the products that are produced for the CYBER 180 range (low-end 639-1 streaming tape with both phase encoding and group code recording capabilities to the 200 ips 679-7) and three families of products for the OEM market:

- The Sentinel series, a 1/4" tape subsystem for use as backup for micro- and minicomputer Winchester disks (between 30-100 MB).
- The Keystone series, a standard 1/2" drive tape line.
- The Patriot 240, a 1/2" cartridge streaming tape drive (240 MB).

DSPG has reversed the earlier decline of its OEM accounts (which now represent 85% of the unit's business excluding the captive revenue of the MPI partners). The quality image has been improved as evidenced by the addition of new accounts such as PRIME, SONY, and COMPAQ. However, a warranty problem on its previously troubled FSD-2 line (9" drives) was identified for which reserves have yet to be set aside (because there is no history to support that action from an audit standpoint). DSPG says they now know how to make these units, so the problem applies only to earlier shipments estimated at less than 50,000 units.

DSPG has a $400-500M contract with AT&T which looks unlikely to be fulfilled. Thought is that AT&T will elect to pay the cancellation charge rather than take units they cannot sell. DSPG has just closed a large contract with Sony for 5.25" drives valued at $80M over three years.

DSPG has paid a high price (over $100M or more) to develop and master the thin-film head technology (TFH). This technology is key to higher performance, higher capacity drives. These kinds of drives are required for the fast growing segments of the data processing industry (example multi-user systems, engineering workstations, expert systems, etc.). While there are now one or two merchant suppliers of TFH they do not have DSPG's capability. DSPG's US competitors do not have this capability in-house: Fujitsu and Hitachi have it. DSPG now intends to market TFH as components. DSPG is currently sole-source supplier for Unisys (old Memorex) and no other source can meet specs with consistent yields. TFHs now cost less than ferrite heads. DSPG has recently announced a second shift for TFH production and now has capacity for 2M heads per year. At $20 per head this represents a $40M business. Estimated internal and captive use is about 50%.

The business sequentation of DSPG is shown in the attached chart. Basis for the analysis is as follows:

Captive business was reduced in 1986 due to the general slow-down in the computer business affecting mainframe companies, and increased in 1987 for the reversal of that trend.

The numbers for 1988 and 1989 were reduced further in the captive business because of Unisys leaving the MPI joint venture. In the over 500 megabyte category it is assumed that "T" will fix its FSD-II problems in 1987 and be able to participate in the significant growth expected in this market in 1988 and 1989. Removable storage drives were not reduced significantly in the ongoing years because of the general trend away from this method of storage. It is inherently less reliable than the fixed disks and really is only needed for activities where data is required to be removed for security purposes or special system requirements. Heads and others shows a significant growth due to "T"'s announcement to enter the merchant head business and its strong technical positin with this component.

In general there will be a shift in the market between "large" and "small" with small growing due to the fact that more storage can be fitted onto ever smaller form factors. There is also the introduction of the 3 1/2" drive which "T" has announced it will start production on in 1988. Over the years, current low capacity 5.25" requirements will be served by higher capacity 3 1/2", and middle and large capacity 8", 9", and 14" drives will be served by higher capacity 5.25".

The overall conclusion from this five year revenue matrix is that the small disk drive business will be growing almost 2 1/2 times in four years. The assumption is that "T"'s effort to increase its capacity of 5.25" will be successful and that the 3 1/2" that it is planning to produce in Singapore will also be successful. The large disk drive business is ever decreasing because of the factors mentioned above. The one anomaly in the trend is the slight uptick from 1987 to 1988. This is caused by an assumption that "T" will get a larger share of the over 500 megabyte market as a result of having cured its problems on the FSD-II and that the removable disk drive business will not have eroded so dramatically between 1987 and 1988 as it does in later years. The long term trend shows a significant decrease in the volume and revenue from large disk drives. This means that there will be over capacity in the large disk drive plants.

Growth in DSPG will come from the new products, particularly the 5.25" and 3.5" drives and optical storage. In 1986, 25% of OEM business came from old products, declining 30% a year, while the remainder came from new products increasing 20% per year. In the workstation and supercomputer markets, DSPG has excellent prospects: it is well placed in the 8" market and has the fastest access in the 100-300 MB 5.25" market. The 5.25" 100-300 MB and the 3.5" (DSPGs new entry) 30-100 MB drive markets are the fastest growing.

DSPG's profit is dependent on cost, yield and quality control in manufacturing operations and on production cycles/learning curves for new products. Most of the current line products take advantage of DSPG's superior thin-film technology. Added revenues from improved relations with OEMs and increased production rates at the Oklahoma City plant should combine to further improve profit margins. DSPG's position in 8"-14" disks is stronger (and therefore under less price pressure) than the 5.25" and below. For a variety of reasons (fewer competitors in the business, Fujitsu raising prices, resolution of the warranty problems and control of the thin film head technology and costs) it is felt that the opportunity to improve profit is better in the large drives than in the small drives. Price/performance pressure on the 5.25" will be severe because of the large number of US suppliers. (However, recent difficulties at Maxtor indicate that producing 5.25" capacities competitive with 8" may be difficult to achieve). The start-up costs of the new 3.5" Singapore plant will depress near-term profits. DSPG's profits could be increased if the present European production could be shifted to the Far-East (not an easy solution).

DSPG has value in four different segments, disk drives, components, optical storage drives and tape drives. The thin-film technology has value as a component business to the OEM market. The resolution of the MPI contractual agreements will represent a problem. All products are sold by a single sales force. However, the sales force is large enough that separate groups could be created for large drives, small drives and optical products. Optical product sales could be as high as $30M in 1987, with a strong growth curve in later years. These sales will not significantly impact magnetic product sales, so revenues will be additive.

Despite reassurances, the 9" drive problem has not been resolved. As it stands today, sales of the unit have practically stopped while customers wait to see the situation more clearly. "T" says it will cost a maximum of $1500 per unit to repair, but doesn't know to how many this will apply nor the total cost which could reach $75 million.

STRATEGY:

Plant Rationalization: The volume trend for large drives will be down as per our five year revenue matrix forecast. Trend for small drives will be up. "T" will have production facilities in the Far East for small drives. "T" will also have production facilities in Oklahoma City for small drives. Because the trend in large drives will be down DSPG will have excess capacity. To reduce capacity of the higher cost German plant should be closed. It may be desirable to have a Common Market plant for small drives. Portugal could provide this facility. Head production should be expanded in the Far East (DSPG present plan). The Minneapolis plant will probably have excess capacity. This may be a multi-site plant (it was once) so downsizing would be possible. Desirable, would be to bring optical drive products to Minneapolis. This would require an agreement with Philips. Other possibilities are non drive products from the rest of the operations - especially if one of the other businesses exited and some residual parts or other support production are needed. There may be possibilities to increase media production in Minneapolis or Oklahoma City. This product requires a high degree of automation. The skills are in DSPG to do this. DSPG is planning rigid disk media production in the Far East.

Adding New Products to Line: The most obvious is the LMSI line of optical storage drives and tape drives. Juke boxes for optical would also be a good product for Oklahoma City or Minneapolis. Tape drives were once made in the Oklahoma City plant. There are some complementary acquisitions possible that could use the productin and distribution of DSPG.

Disposal of DSPG: If it were desirable to dispose of DSPG it would best be done in two pieces: 1) disk drives and 2) "T"'s interest in LMSI. Because of the forecast decline in large disk drive business it is not likely that it could be sold separately - except to someone who wold just want to cash it out. While we tend to look at large and small as separate businesses, they probably are not. Customers are buying form factor (19" relay rack to 3 1/2" PC), capacity, access time, and transfer rate. Generally there is a trade-off among these factors, but it is constantly changing generally in favor of more and faster in smaller form factors. No buyer of large would want to be restricted from going into the small disk drive business. No buyer of the small disk drive business would want the owner of the large disk drive business to be able to compete with him. This then leaves two choices for disk drives: a) sell all, or b) sell separately with the buyer of the large in a run out or liquidation mode.

Thin film head technology is a strong incentive for a buyer of the business. The thin film head business could be sold separately but it would damage the value of the remaining business and reduce the number of possible buyers. A rough estimate of the value of the large disk drive business on a cash out basis would be between $200-250 million. Under this scenario the thin film head business would go with the small disk drive business and parts would go with the large disk drive business. This is probably not a pure division since the small disk drive business also has some parts. However, using a factor of 1.8 x expected 1988 revenue the small disk drive business would have a value of 460 x 1.8 equals $828 million. Thus, if we used 200 for large business and 828 for the small we have a total value of $1,028 million. To this one should add the value of "T"'s interest in LMSI of about $70 million. Total valuation of the business is between $900 million and $1 billion: "T"'s share of this would be worth $850-950 million. Two factors would affect the valuation rather dramatically: 1) does "T" really have the

FSD-II fixed and can it hold the customer base for this product, and 2) does it have a good competitive 3 1/2" design and will it be able to get its market share of this very rapidly growing portion of the small disk drive business.

BUSINESS SERVICES

Last Updated: 08/11/87

GROUP: BUSINESS SERVICES, David P. White, Exec. VP & President

PRINCIPAL DIVISIONS:

- Arbitron (Anthony J. Aurichio, President)
- "T" Business Centers (Pat Delaney,President)
- Quorum (Harry Beisswenger)
- Financial Services (Charley Brown, President)
- Business Information Services (Don Vacheron)

BUSINESS:

BSG was established in 1984 and provides processing services, software products and turnkey systems to over 20,000 clients US-wide. Target markets include Banking, financial services, broadcasting, manufacturing,legal services, Fortune 1000 companies and small businesses. Revenue for the group in 1986 was $ 445.6M (a 2.6% increase over 1985) and made a significant contribution to profits. Revenue gains were largely due to Arbitron and Financial Services. Arbitron acquired the assets of Broadcast Advertiser Reports, Inc. in December, 1986. Healthcare services were partly sold off (medTEC to Cycare, HELP to 3M) and partly closed down. The business breaks down into four categories of services (which group the units together but which are not all operations in their own right): Marketing Information Services including Arbitron and licensed software, Management Services including the Data Centers, Quorum and administrative services Financial Services includes credit union services, licensed software, DECIMUS/ACTION and securities trading and Operations Services provides communications and data center operation to "T".

Last Updated: 08/11/87

GROUP: BUSINESS SERVICES (David P. White, Exec. VP & President)

UNIT: Arbitron (Anthony J. Aurichio, President)

RESULTS:

	1987		1986	
	Revenue	OP	Revenue	OP
	180	30	150	20

MARKET:

Arbitron Ratings Co. provides broadcast audience measurement services in competition with A. C. Nielsen, Pulse and others. Data is collected via metering devices (Scan America), telephone (Arbitron's own staff) and diaries held by viewers/listeners. Lifestyle cluster analysis by zip code is also provided through the ClusterPlus service. Services include:

- Audience measurement services are provided to more than 6,000 clients. Included are 600 television stations, 1,900 radio broadcasters, and over 3,500 advertisers and agencies.
- Arbitron's field staff of more than 3,000 contacts about 2.5 million households annually to obtain television-viewing and radio-listening information.
- Data on viewing and listening habits are collected through diaries and, for some television audiences, through metering devices.
- Arbitron metering services are available in 11 markets--New York, Chicago, Los Angeles, San Francisco,

Philadelphia, Boston, Detroit, Dallas-Ft. Worth, Washington D.C., Houston, and Miami. There are 350 to 500 meters installed in each city.

- Arbitron provides information on the demographics and lifestyles of a television or radio audience in a market by merging its audience data with ClustPlus^{SM}---a lifestyle segmentation system developed by Donnelly Marketing Systems. ClusterPlus describes the lifestyle characteristics of the people who live in a particular Zip Code. Each description is called a lifestyle cluster and is a measure of hundreds of variables like age, sex, income, occupation, family size, and mobility. The clusters describe the kinds of consumers the residents of particular Zip Codes in a market represent.
- Arbitron also merges its information with Simmons Market Research Bureau Product User Profiles. Simmons conducts surveys of product preferences by consumers. The profiles of product users are matched to the appropriate ClusterPlus lifestyle clusters to show buying tendencies among the different lifestyle groups in a radio or television audience.
- ScanAmerica, announced in 1984, is a syndicated

research service using electronic technology to measure television viewing and product purchasing within the same household.

- The ScanAmerica electronic meter monitors television viewing in detail: the age and sex of everyone watching; the channel, broadcast or cable being watched; the exact time and length of viewing; and the use of VCRs or home computers with the television set.
- ScanAmerica uses a portable in-home scanner to track products brought into the household by recording the products' Universal Product Codes. The television viewing and product information is stored by the meter, transferred to the main computers for processing and is used to produce reports for advertisers and braodcasters.

ScanAmerica technology was tested in a pilot study of 200 households in Denver. Based on the resulting data, the Denver service was expanded at the end of 1986 to 600 households to produce syndicated reports for use by broadcaster, advertisers, and agencies. It has just signed its first television station KDVR-TV in Denver.

- Arbitron Ratings Company has twin "T" 3500s and seven CYBER 120s in Beltsville and uses two "T" CYBER 760s and one CYBER 730 in the Cybernet Center in Rockville.

The overall market for market information services is led by A.C. Nielsen who has been pushing the use of audience meters and other automated data collection devices. Basic business demand will grow slowly as cable, satellite, and VCR services change the market.

The addition of BAR will increase the unit's growth rate to approximately 18% in 1987 (from a 12% growth in 1986). This and other Business Services operations are the subject of cost-cutting and consolidation moves to reduce operating expenses.

Arbitron has grown steadily at approximately 12% AAGR and is beginning to benefit from the interest in at-home shopping. The unit is competitive and well positioned in growth markets. There has been slow but steady growth in the demand for ratings services themselves but high interest in "integrated services" where two or more data sets are cross-correlated to generate a new perspective on consumer purchasing patterns (e.g., Arbitron's SCANAMERICA). This offers scope for acquisitions of companies which are in related but distinct markets - an enormous field.

The unit is wedded, by investment in software, to the use of "T" mainframes, which are not the most efficient or price/performance competitive in the market. The long-term concern must be how to bring the extensive systems off of "T" equipment and make the transition to DEC/Tandem/Cray/IBM depending on the analysis. Automated data capture can replace many of the 3,000 field staff with the attendant savings but there exist multiple opportunities to merge other related companies' operations to expand revenue and create new products.

Last Updated: 08/11/87

GROUP: BUSINESS SERVICES (continued)

DIVISION: "T" Business Centers (Pat Delaney, President)

"T"'s Business Centers, although reduced in numbers, provide batch and remote batch processing services to over 12,000 small and medium-sized businesses. Applications include human ressource management, payroll, payroll tax filing, A/R, A/P, general ledger and other financial reporting services.

"T" Business Centers (TBC) provides batch and remote batch processing services and software products to well over 12,000 small- and medium-sized businesses.

- Applications available through processing services include:
  - Payroll 4.
  - Payroll Tax Filing.
  - Human Resource Management System.
  - Job Cost Analysis.
  - Labor/Performance Analysis.
  - Accounts Payable.
  - Accounts Receivable.
  - Sales analysis.
  - General Ledger and Financial Reporting.
- TBC markets Orchestrator™, a software product designed for IBM PC and compatible microcomputers, that links TBC's mainframe computers with a client's in-house desktop computer. Orchestrator licenses for $3,600, with a monthly maintenance fee of $35.

- TBC clients come from a variety of industries with the heaviest concentration of service to mid-sized companies with $500,000 to $50 million in revenue and with 50 to 5,000 employees.
- TBC operates approximately 36 sales offices nationwide. Processing is performed at data centers in Cleveland and 30 local processing centers. In Cleveland TBC uses two IBM system 370s model 158 and six IBM 3032s.

"T" originally targeted companies with sales of $20 - 500 million. Now they are finding much larger companies buying. The demand now is for integrated services e.g., with Human Ressource Management and other personnel processing accomplished with payroll using integrated records.

It has taken many years to make necessary changes in "T"s data centers and to adjust to doing business in the 1980's (e.g., placing PCs at most payroll/personnel clients sites for direct data entry) and integrating services. This has now been accomplished, at the hardware (two-way micro-mainframe links) and service levels (in particular with ORCHESTRATOR a payroll/personnel package).

The unit has had steady but slow growth and continues to benefit from demand for all of its services. In-house conversions of processing services to micro and mini based systems are nevertheless a drain on the customer base. However, TBC has attached this trend by providing micro-based front end services. The most exciting development is the sudden demand from large companies for standard services, which could significantly impact growth and profit.

Much of the obvious reduction in data center capacity has already been achieved. Revenue growth is the only real answer to sustained profit in the long term although some cost reduction can be expected from a drop in communications costs.

The unit has value mainly for the business volume it transacts. There are many competitors who would purchase the customer base and business "as is" with the intent of converting them to their own brand of equipment and systems ultimately. These include ADP, Paychex and Bank of America.

GROUP: BUSINESS SERVICES (continued)

DIVISION: Quorum (Harry Beisswenger, President

MARKET:

Quorum is the result of the merger in 1985 of Compute-R-Systems a provider of automated data processing for law firms and "T"'s own Legal Support Services. It provides processing services, software products and turnkey systems based on predominantly DEC VAX systems to over 300 law firms and corporate legal departments for timekeeping and billing and litigation support.

Quorum Systems, based in Plymouth Meeting (PA), provides processing services, software products, and turnkey systems to over 300 law firms and corporate legal departments for timekeeping and billing, word processing, and litigation support.

- Timekeeping and billing services and systems include:
  - The Service Bureau Management System, a remote batch processing service.
  - The On-Line Timekeeping and Billing Service, an interactive processing service.
  - Management Program 1500 (MP 1500) software, designed to run on DEC VAX computers, is used to track timekeeping and client accounting functions and produce various management reports. The software is priced from $40,000.

- Management Program 2000 (MP 2000) software offers expanded capabilities through its use of relational data base technology and is designed for use on DEC VAX computers. MP 2000 is priced from $70,000 to $500,000.
- General Ledger, Accounts Payable, Docket Control and Conflict Checking software modules are available as options for use with MP 1500 and MP 2000.

- Word processing software includes:
  - WORD-II, running on DEC PDP-II computers.
  - MASS-II, running on DEC VAX computers and various IBM PC-compatible microcomputers.

- Litigation support services and products include:
  - PALLAS, a litigation support processing service.
  - BASIS, a litigation support software product for "T" CYBER, DEC VAX, IBM, and Prime computers. BASIS is priced from $30,000.
  - INMAGIC™, a litigation support software product for DEC Rainbow, PDP-II, and VAX computers and IBM PCs. INMAGIC pricing starts at $8,000.

- Quorum uses "T"'s network to support litigation services. Timekeeping and billing services are processed on a Univac 9080 in Plymouth Meeting (PA).

The development of CD-ROM storage for PCs has made possible the in-house processing of litigation support. This will slowly impact the Quorum business as greater capacities and more flexible (read/write) capabilities are brought into the optical storage market.

The growth has been slow and is unlikely to improve because the alternatives open to the typical customer or prospect are legion. The most important are micro-based systems that bring processing in-house.

Profit improvement seems a likely trend for this unit as it stands, but significantly greater revenues and profits would only come from new services that integrate multiple aspects of a typical law firm's practice or the acquisition of revenue and client bases from existing competitors. In the absence of either of these, Quorum must depend on continued/increased demand for its basic services in a competitive market.

Last Updated: 08/11/87

GROUP: BUSINESS SERVICES (continued)

DIVISION: Financial Services (Charley Brown, President)

MARKET:

Financial Services provides processing services and turnkey systems based on DG systems to over 1500 credit unions, commercial banks, financial institutions and retail organizations. Main services include FOCUS (on-line and batch credit union service) EFT/payment authorisation services (to banks who retail the service to merchants) Commercial Loan, DDA, CIF, ATM and other services (to financial institutions) and Cybercredit (debt-collection system to financial/retail companies). It also provides services to financial traders.

This unit, FS, consists of five separate and completely separable units:

	1986 Revenues ($ Millions)
Credit Union Services	30
Action Data Services	10
Banking Services	15
CYBER Credit Services	2
Micrognosis	31
TOTAL	~985 million

Equipment use by the units:

- Credit Union Services has two IBM 3031s and two IBM 3033s as backup in Campbell (CA) for on-line processing. Batch services use IBM 4300 Series computers located in 24 branch offices.
- EFT Data Services uses the Business Information Services' computers located in Cleveland.
- Banking Services has five IBM 370/158 computers and one ATM Switch, dual HP 1000s installed in Los Angeles.
- ACTION Data Services has one IBM 370/158 and two IBM 4341 II computers installed in St. Louis.

Financial Services groups within Business Services include Credit Union Services, EFT Data Services, Banking Services, ACTION Data Services, CYBERCREDIT services and Micrognosis.

- Credit Union Services provides processing services and turnkey systems to over 1,500 credit unions in the U.S., serving over 6 million individuals.
  - Credit union services are marketed through six service options:
    - FOCUS II, a batch service.

- OCUS, a special batch service available only in Ohio.
- FOCUS 300, an on-line service offered with fewer functions and at a reduced cost for smaller credit unions.
- FOCUS IV, an on-line service offered at a reduced price when used during nonprime time.
- FOCUS On-Line, the complete on-line version with no price reductions.
- FOCUS ONE, a standalone in-house computer system for use in large credit unions.

. Approximately 800 credit unions use the FOCUS and OCUS batch services, and 600 are on-line users. All on-line services are provided from a data center in Campbell (CA). Batch services are provided from data centers now under the "T" Business Center organization.

. Minneapolis Federal Employees Credit Union has signed a $1 million pact for FOCUS ONE deposit and loan accounting system. The credit union is the third largest in Minnesota, with $142 million in assets and 54,000 members. The FOCUS ONE package includes on-line ATM operations, and variable-rate loans.

- Applications available in the on-line version of FOCUS are:
  - Share draft and loan draft processing.
  - Automated share and loan postings.
  - Certificate processing.
  - General ledger and financial reporting services.
  - Check preparation.
  - Delinquency notices and management reports.
  - EFTS funds deposit.
  - VISA credit card support.
- FOCUS ONE, the standalone in-house computer system, has been installed in about 100 credit unions since it was introduced in 1980.
  - FOCUS ONE operates on an IBM Series I and ranges in price from $140,000 to $1.1 million depending on software and peripherals required.
  - All application software available on the on-line service is offered on FOCUS ONE plus on-line ATM, audio response, and integrated credit card systems.
- Credit Union Services also markets a Distributed Data Processing (DDP) system using a Data General MP 100 system in conjunction with its on-line

service.

- EFT Data Services, based in Greenwich (CT), provides payment authorization services to commercial banks which, in turn, market the service to retail merchants.
  . EFT's TeleMoney Service enables commercial banks to provide point-of-sale check verification, check guarantee, and credit card authorization services.
  . Retail outlets are connected via terminals or direct links to the TeleMoney on-line transaction system.
  . Mail order providers have the ability to access the TeleMoney application via a Dial Batch service.
  . EFT Data Services currently has over 35 commercial bank and bank associate clients.

- Banking Services provides fundamental application accounting processing services to financial institutions from data centers in Los Angeles, San Francisco, and Cleveland.

- Applications available include:
  - Commercial Loans.
  - Demand Deposit.
  - Customer Information File.
  - Savings/Time Deposit.
  - Installment Loans.
  - Real Estate.
  - ATM.

- ACTION Data Services, based in St. Louis, provides on-line, real-time data processing services to the financial services industry. ACTION currently provides services to over 115 customers who operate over 1,800 offices throughout the U.S. and Canada.
  - ACTION offers services and support products for processing consumer loans, revolving lines of credit, certificates of deposit, savings accounts, and commercial loans.
  - On-line capabilities include:
    - Calculation of interest, service charges, APR, insurance premiums, payment schedules.
    - Document preparation for loan and thrift accounts.
    - Loan disbursements/check writing.
    - Credit scoring calculations/demographic data capture.
    - Variable rate support provided for all products.
    - Payment processing/calculations and history records.
    - Refund calculations - interest, insurance, etc.

  - Cashier/teller balancing/totals.
  - Comprehensive on-line reporting.

- A number of features and reports are available to support each service including off-line reporting.
- ACTION Data Services also supports Distributed Data Processing and provides a credit collection system for DDP systems.

- CYBERCREDIT II is a debt collection system marketed to financial and retail organizations. It is provided both in a turnkey system and as add-on software. This software isoffered on DEC VAX and Micro VAX computers. A software-only version for IBM computers is anticipated for 1986-1987.
  - CYBERCREDIT II capabilities include:
    - On-line tracking of delinquent account portfolios and collection activity to date.
    - Automated scheduling of collection contacts and followup.
    - Collector controlled personalized letter generation.
    - Support of multiple products and organizations on one system.
    - Management reports that provide information about the portfolio and collector productivity.
  - CYBERCREDIT II software license fees range from $50,000 to $190,000.

. There are currently over 25 organizations using CYBERCREDIT.

MICROGNOSIS: In 1986, Micrognosis had revenues of $42 million. It is 74% owned by "T" and the remainder by its employees. It will grow about 35% in 1987. Micrognosis currently has 270 employees. In comparison, its primary competitor, Rich, is owned by Reuters and has revenues of $95 million with 890 people.

Its major product is the TRADE system which supports traders in the world financial markets. The trader can access, organize, and manage multiple information sources in individual and combined displays.

Micrognosis supplies turnkey systems and designs the traders' work environment.

Its headquarters was moved from the U.K. to the U.S. in 1987.

Last Updated: 08/11/87

GROUP: BUSINESS SERVICES (continued)

DIVISION: Business Information Services (Don Vacheron, President)

MARKET:

Business Information Services provides remote computing and distributed processing services. PLATO Instruction serices, and a range of financial, economic and marketing data bases are also provided, as well as standard services in the manufacturing/distibution, health care, government and banking/finance arenas.

Application emphasis has shifted to "Management Application Systems" characterized by:

- Multiple users, often in different locations.
- Multiple data bases, combined and/or shared between departments.
- Use of outside data, integrated with in-house data.
- "Seed Modules" of software, which may be used as is but are designed to be tailored to meet unique local conditions.
- Inter-related, integrated applications.

Examples of Management Application Systems include:

- MARKSMAN, a marketing system that facilitates day-to-day operation and planning in areas like advertising, promotion, annual planning, sales forecasting, profit and loss planning, market research, territory operations, customer relatins, and sales management.

- ACTIVATOR, a process manufacturing system that includes modules for: Performance Analysis, Yield Management, Operations Scheduling, Financial Management, Lot Tracing, Process Costing, Capacity Planning, Resource Planning, Material Management, and Distribution Planning.
- TREASURY COMMAND, a financial management system that facilitates the day-to-day operation of the corporate treasury management function in areas such as cash management, bank balance reporting, deposit reporting, bank relationship management, debt and inestment portfolio management, cash forecasting, commercial paper issuance, and corporate trade payments. The system also provides links to in-house accounting and general ledger systems for complete integration.

In former years, all processing was done remotely at the BIS data center. The division has since expanded its offerings to "process where it makes sense." For example, the "T" Distributed Service makes the Mangement Applications Systems available on a Wang VS/100 or on IBM 43XX located at the customer site.

Similarly, various links allow the integration of popular micro-software packages, such as Lotus 1-2-3 or "T"'s Visi On™ applications. This provides flexibility in accessing and transferring data and in moving workloads to the appropriate resource--micro workstations, in-house mainframes, departmental minis, or the BIS Cleveland system.

The BIS PLATO Instruction Series provides customer training through a combination of video, on-line, and microcomputer lessons. This provides for uniform customer education, independent or geographic location or schedule requirements.

A range of data bases covering financial, economic, and marketing data continue to be available to be integrated with the Management Application Systems.

A profile of the applications offered on the BIS network is presented in Exhibit 1.

Business Information Services' data center in Cleveland includes one IBM 4361, two IBM 3032s, five IBM 3033s, one "T" Omega II, and one Wang VS 100.

Traditional timesharing services have fallen, but the advent of EDI has offered at least one area of new revenue development. BIS has offered EDI since 1984 and now has some 100 customers up on the REDINET family of EDI products executing purchase orders and invoices electronically. This is a growth market.

"T"'s EDI BUSINESS:

Processing Services:

"T"'s Redinet Intercorporate Business Transaction System (Redibits) was announced in late 1984 and introduced in Spring 1985 under a joint marketing agreement with AT&T. The system uses AT&T's Accunet as the transmission network, with AT&T responsible for network marketing under the name of RediAccess.

EDI Software was developed by Program Sciences Incorporated (PSI). "T" handles EDI processing, installs and maintains customer premises equipment, and administers the software through an arrangement with PSI.

RediNet supports all X12 standards. The services has been endorsed by the American Supply and Machinery Manufacturer's Association, the National Industrial Distributor's Association and the Southern Industrial Distributor's Association.

Redi-Agent service is a customized EDI transaction retrieval and forwarding service designed to assist suppliers in accessing large companies maintaining private EDI networks.

- "T" acts as an authorized agent to access and retrieve business information from one or several private EDI systems.

- Translations, as necessary, are performed.

- Data is then forwarded to the customer's Redinet mailbox or delivered via a dial-out directly to the company.

"T" markets the EDI processing service through its Lakewood (OH)-based MIS division.

- This approach was taken to combine product ownership, technical expertise, and marketing.

- The company feels this integration will lead to superior service, one of the few areas where a vendor can differentiate, and better responsiveness to

L customer's needs.

- Since inquiries regarding EDI often originate from IS departments, having technically-oriented personnel as the first customer interface can lead to innovative responses to technical considerations. The company believes this approach may make the difference in closing sales.

By jointly marketing EDI services with AT&T, "T" shares its costs. Marketing costs can severely impact profitability and may be one reason why AT&T's own Net 1000 failed.

"T"'s earlier proposed Network Transfer Service EDI clearinghouse has been abandoned.

- It was intended to encourage third-party vendors to address internetworking issues.

- Currently, Redinet does support internetworking with both GEISCO and McDonnell Douglas, only charging for one side of transactions forwarded or received through a third party.

Redinet pricing is based on volume and delivery priority, with volume discounts available. The company does not charge a start-up fee. There are also no monthly minimum or per transaction storage or connect-time charges.

Software Products:

Mailbox and related services are Redinet's core business. However, customers expressed needs for one-stop-shopping, and in particular for translator software. In response, "T" developed Redi-Micro, which was beta tested through most of 1986 and officially announced in December.

Redi-Micro runs on IBM PC/XTs, ATs, and compatibles with at least 256K memory and 10 Mbytes of hard disk. Transmission can be from modem to modem or via "T"'s Redinet service.

Unlike other EDI software vendors, who have either linked a translator into business applications or created a generic product that can support a large variety of document types, "T" chose to limit itself to three X12 documents.

For $500 a user can purchase either a purchase order, invoice, or materials release (including shipping notice) module. For an additional $200, he can purchase either an asynchronous or bisynchronous module.

In addition to this already low price, Redinet will offer substantial discounts for volume discounts.

The modules are generic and geared towards smaller companies and firms seeking to jump aboard the EDI "bandwagon" without delay. The products are particularly useful to small firms needing to communicate with larger trading partners.

Redi-Micro is being distributed directly to "T"'s salesforce. There are no agreements for either "T" to distribute other vendors' software, or for other vendors to distribute "T"'s. "T does, however, have a standing offer to all software vendors. It will proide two free mailboxes for developing interfaces to Redinet.

Summary:

INPUT estimates that Redinet had less than $1 million revenues in 1986; since Redi-Micro was not introduced until December 1986, "T" posted no revenues from EDI software that year.

In 1987, "T" has about 100 customers for its EDI software and service.

TRAINING & EDUCATION/TICKETRON

Last Updated: 08/11/87

GROUP: TRAINING/EDUCATION/TICKETRON (George Troy, President)

PRINCIPAL DIVISIONS:

- Training and Education
- Ticketron
- Health Care (sold/closed down)

Revenue for the group was $218 million in 1986 representing a drop of almost 20% from the 1985 revenue level of $273. This unit included Systime, a U.K. operation, which had major restructuring in 1986 including the sale of over 50% of its business. The remaining part of Systime now reports in the Computer Systems Group. The health care activity was closed down and sold in 1986 and early 1987.

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GROUP: TRAINING/EDUCATION/TICKETRON (continued)

DIVISION: Training and Education Group (T&E)

The T&E Group was formed in late 1986 to consolidate a number of the Company's diverse training and education markets.

The Group which had approximately $90 million of revenues in 1986 provides applications and services for training, education and job creation. It provides training and testing services to selected industry segments, job training to individuals through "T"'s Institutes and government-funded employment preparation centers, computer based education for schools and junior colleges, and consulting services to help create jobs through the growth of small businesses.

Losses in 1986 included restructuring changes primarily associated with the writedown of certain real estate investments.

MARKET:

"T" has been selling training and education services to schools and universities, business and industry, government and the military, and to consumers for 25 years. These have involved the delivery of training courses (both standardized and customized) through classroom, computer-driven, video and other means using "T"'s own sites of customer sites with time sharing of mainframes and with micro computers.

Specific target markets are identified as:

- Manufacturing.
- Aviation.
- Consumer vocational training (computer related).
- K-14 schools and colleges.
- Government funded job training programs.

The industrial training marketplace (e.g., job related training paid for employers) is estimated to be $35 billion per year and growing at a rate of 5% annually. The fundamental school market is much larger, but the currently accessible portion is proportionate to the willingness to spend money for computer and courseware as adjuncts to classroom teaching. This is currently estimated at $10 billion per year (mostly hardware) but growing at better than 10% per year. The content for courses using computers as a principal training element deals both with computer related subjects and with general subject matter. It is far more prevalent to use computer based training for computer related subjects than for general subjects.

This area was of great importance to former Chairman Norris and received what many feel was disproportionate management attention and money over the last 25 years. Some estimated $900 million was invested in PLATO related efforts. Nevertheless, there is a large investment (mostly written off) in bricks and mortar (for training centers), course authorizing and execution systems (PLATO for mainframes and micros) and courseware (both for computer training and general classroom use).

All operations have undergone considerable downsizing through 1986 and 1987 after having incurred significant losses for several years. The unit continues to lose money and further consolidation is occuring. The company disolved a joint venture with WICAT Systems, Inc. which had provided computer-based education products to the K-12 market.

There were training facilities in 50 cities as of the beginning of 1987. "T" also offers a substantial number of courses at customer sites. Previous published studies (by Talmis and other) have identified "T" as the largest provider of training services (excluding book publishers). Competition includes Deltak and ASI as well as product and course offerings from many computer oriented and non-computer oriented training organizations (AMA, various universities, Chubb, AGS, On-Line Software International, CSR, Goal Systems, Boeing Computer Services, etc.). Analysts have not been optimistic with respect to the outlook for this business due to its labor intensive nature. The attempts to leverage the sources through video cassettes, computer-based training and now interactive video have not been successful (exceptions are ASI, Goal and Deltak). The schools market has been very elusive. In general, in spite of glowing forecasts, this marketplace has not matured so that vendors can be of substantial size and reasonable profits.

STRATEGIC ASSESSMENT:

"T" appears to be on a path to stabilize or further reduce the training and education business. PLATO itself seems to be on a "back-burner" (witness the discontinuance of their joint venture with WICAT). But there is no reason why this business cannot generate profits if carefully targeted with minimum in-house investment in new educational technology and effective use of third parties to author new courseware. There is a considerable data training industry with a significant computer based training segment.

American Airlines has become the first customer for "T"'s new microbased PLATO Aviation Training System. The $1 million system is providing ground school training to more than 500 cockpit crew members each month at the company's Flight Academy. The Aviation

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GROUP: TRAINING/EDUCATION/TICKETRON (continued)

DIVISION: Training and Education Group (T&E) (continued)

Training System includes PLATO cluster technology, which links industry-standard micros with "T"'s PLATO Personal Training Station through a local area network.

T&E is marketing other companies' products:

- Education Support System is a software package from Software Management.

- Test Development System from TESCOR which allows educators to create, compose, print, and score testing instruments. It is contained on a 550 MB CD-ROM.

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GROUP: TRAINING/EDUCATION/TICKETRON (continued)

DIVISION: Ticketron

MARKET:

Ticketron provides computerized lottery services to the states of New York, Illinois, Maryland, Pennsylvania, Washington and Delaware and two off-track betting systems in upstate New York. Ticketron also supplies an on-line ticketing system in 22 states and Canada that links consumers to theater, sports, cultural and other events, as well as to the national and various state park systems.

Nearly $80 million, or about two-thirds of its revenue, came from Delaware, Illinois, Maryland, New York, Pennsylvania and Washington, where Ticketron operates the computerized lottery networks. Ticketron also operates nearly 600 automated ticketing outlets for sports and entertainment events in 22 states and Canada.

"T" attempted to sell Ticketron in 1986 for $140 million to Allen & Company but was unable to obtain approval from the State of Illinois. Subsequently, the need for cash was no longer as acute due to "T"'s successful debt and debenture offer.

Recently, "T" introduced its CYBER 180-930 system to lottery organizations in 30 states and provinces. This industry is a major target for the 930 along with "T"'s new on-line retail terminal.

Recent technical efforts have concentrated on developing a new automated wagering system base don the newest CYBER technology and a new wagering terminal. It will be available in 1987 for shipment.

In 1986, "T" introduced a micro-based accounting and administrative system associated with ticket sales. The development of the new ticketing system comes at the right time: the existing systems are for the most part obsolete from a technical standpoint. Ticketron is gradually moving to extend its services from ticketing to the complete ticket accounting function and administration on a turnkey and facilities management basis. Ticketron's on-line ticketing system operates through remote and box-office ticketing terminals and a telephone ticketing network. It has contracts with a large number of sports and entertainment facilities and event promotion to distribute tickets.

Ticketron has expanded its relationship with the Natinal Park Service. A new five-year contract extends Ticketron's services from providing reservations to handling more of the park system's administrative functions.

Main competition to Ticketron in the computerized lottery services comes from GTECH which had 1986 revenues from this source of almost $130 million up from about $80 million in 1985. In the ticketing area there are several local competitors such as Bass in California.

Lottery services contracts are primarily long term operating contracts with ownership of the equipment retained by the vendor. Most of Ticketron's business stems from such relationships initiated in the 1970's. Recently, GTECH has obtained contracts in Ohio and California involing the sale of the computers and terminal equipment to the states and associated operating contracts. This type of contract implies less of a "tie-in" by the vendor since the state can recompete the operations activity separately from the equipment.

Despite the growth of the underlying demand for ticketing and wagering, Ticketron made no progress in revenue in 1986 and expects a flat year in 1987. It needs new systems and more aggressive marketing.